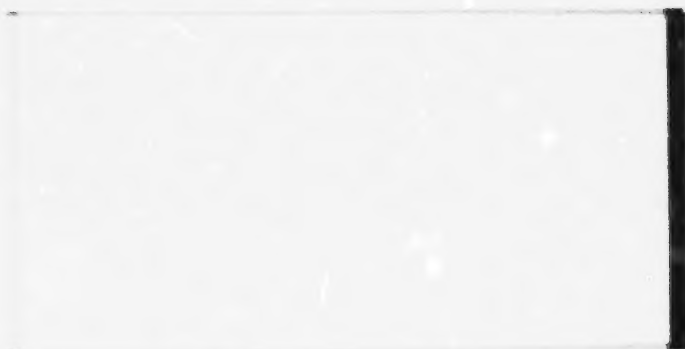






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**PICKERING GS 'B'
PREOPERATIONAL BIOLOGICAL STUDY,
YEAR III, 1981, 1982**

Report No 83-193-K

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ABSTRACT

Physical-chemical and biological characteristics of the near-shore environment of Lake Ontario near Pickering were studied in 1981, the third year of the Pickering GS 'B' preoperational studies. In the water samples copper was the only metal found in levels in excess of the MOE objective for the protection of aquatic life. Of the surficial sediment components analyzed, iron was the main constituent identified followed by manganese. Attached algae were found on all suitable substrate surveyed during August and October but not in July. The composition of phytoplankton and zooplankton was similar to that collected in 1979 and 1980. Their distributions were not directly related to the distribution of the thermal plume of Pickering GS 'A' although their densities were frequently higher around the stations. The most common zoobenthic organisms encountered were oligochaetes, midges and amphipods. Benthic organisms were more abundant at the 7 and 12 m depths than at the 3 m depths where organic content of the sediment samples were lower. Alewife was the most common species in the larval, juvenile and adult fish samples. Several common fish species including pumpkinseed, white bass and white perch were found in higher abundance at the Pickering GS 'A' discharge than at the other locations sampled. Mallard, Canada Goose, Black Duck and Common Merganser were the major waterfowl species observed. Largest densities of dabbling and diving ducks were recorded at the station sites after freeze up of marshes.

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ontario hydro research division

To Dr. W.R. Effer
Design and Development Division

PICKERING GS 'B' PREOPERATIONAL BIOLOGICAL STUDY, YEAR III - 1981, 1982

1.0 INTRODUCTION

At the request of the Environmental Studies and Assessments Department, Design and Development Division, the final year of the three-year preoperational aquatic biological surveys at Pickering GS 'B' was conducted from April 1981 to April 1982.

The Pickering Nuclear Power Development consists of twin stations, Pickering GS 'A' (operational) and Pickering GS 'B' (under construction). Each station consists of four CANDU reactors with a per station output of 2168 MWe. The across-plant design temperature rise is 11°C above ambient, and the maximum volume discharge is 114 m³/s at full load. The two stations have a common surface intake for their condenser cooling water system, but have separate discharges. Pickering GS 'A' discharges its cooling water to the west of the stations, while Pickering GS 'B' will discharge to the east of the stations. In addition, Pickering GS 'B' has a discharge tempering system designed for it which Pickering GS 'A' does not.

The 1981 net capability factor for Pickering GS 'A' Units 1, 2, 3 and 4 were 88, 84, 89 and 91% respectively. Each unit had a minimum two-week planned maintenance outage period. At least three units were operational simultaneously over most of the year except for a brief period in early September when Unit 3 had a forced outage while Unit 4 was undergoing maintenance.

1.1 Objective

The objective of the three-year preoperational study at Pickering GS 'B' is to describe the biota of Lake Ontario in the vicinity of the station in adequate detail to permit detection of any measurable effects of the operation of Pickering GS 'B' when comparisons are made with postoperational data.

1.2 Scope

The third year of this study examined the spatial distributions of the aquatic flora and fauna in the study area at various times of the year. The biota studied included attached algae, phytoplankton, zooplankton, zoobenthos, larval fish, juvenile and adult fish, and waterfowl. In addition a larval whitefish study was conducted in the early part of the year and a whitefish spawning study was conducted towards the end of the year. The results of the whitefish spawning study are presented in a separate report (Ontario Hydro Research Division Report No 82-539-K). To describe the study area adequately and to supplement biological data, physical and chemical parameters were also monitored.

Physical and chemical parameters also monitored to supplement biological data included water temperature, dissolved oxygen, water transparency, sediment accumulation rates, and water chemistry as well as heavy metal analysis of water and sediments. Sampling was conducted between April and December 1981 for most parameters but continued until March 1982 for waterfowl. The sampling schedule is summarized in Table 1.2-1.

1.3 Study Area

The Pickering Nuclear Power Development is located on the north shore of Lake Ontario approximately 32 km east of Toronto. The study site encompasses a 5.5 km stretch of shoreline from just east of Frenchman Bay to Simcoe Point at the eastern limit (Figure 1.3-1). There are three natural tributaries in the area of the Pickering site; the Rouge River and Frenchman Bay in the west, and Duffin Creek to the east of the site. The discharge of Pickering GS 'A' is the highest volume outlet in the area. The gradient of the lake bottom perpendicular to the shoreline is moderate, with an approximate increase of 8 m in depth per kilometre offshore.

The grid sampling points for phytoplankton and zooplankton were located on 12 transects (D to O) running perpendicular to shore and spaced 500 m apart (Figure 1.3-2). The regular survey transects are the same as those used in 1979 and 1980 (Ontario Hydro Research Division Report No C80-20-K). These locations are shown in Figure 1.3-1.

TABLE 1.2.1

AQUATIC STUDIES 1981 SAMPLING SCHEDULE

Sample Type	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sedimentation		X	_____		X	_____		X	
Temperature & DO Profiles and Transparency		X	X	X	X	X	X	X	X
Water Chemistry		X		X		X		X	
Sediment Chemistry		X	_____		X	_____		X	
Attached Algae			X		X		X		
Phytoplankton		X		X				X	
Zooplankton		X		X			X		
Zoobenthos			X		X		X		
Fish - Larval	XX	XX	XX	XX	XX				
- Juveniles & Adults		X	X	X	X	X	X	X	X
Waterfowl		Jan - Apr '82				X	X	X	X

1.4 Dredging of Pickering GS 'B' Discharge Channel

Dredging of the Pickering GS 'B' discharge took place between August 14 and September 16, 1981. This operation required that the 3 m and 7 m spars on the Pickering GS 'B' discharge transect be moved and left 50 m east of their original position until the end of the year. Dredging operations may have influenced sedimentation rate results as well as sediment and water chemistry and zoobenthos results in this area.

2.0 METHODS

Sampling methods and apparatus were those currently employed by Ontario Hydro Biological Surveys and are described in Ontario Hydro Research Division Report No 82-266-K.

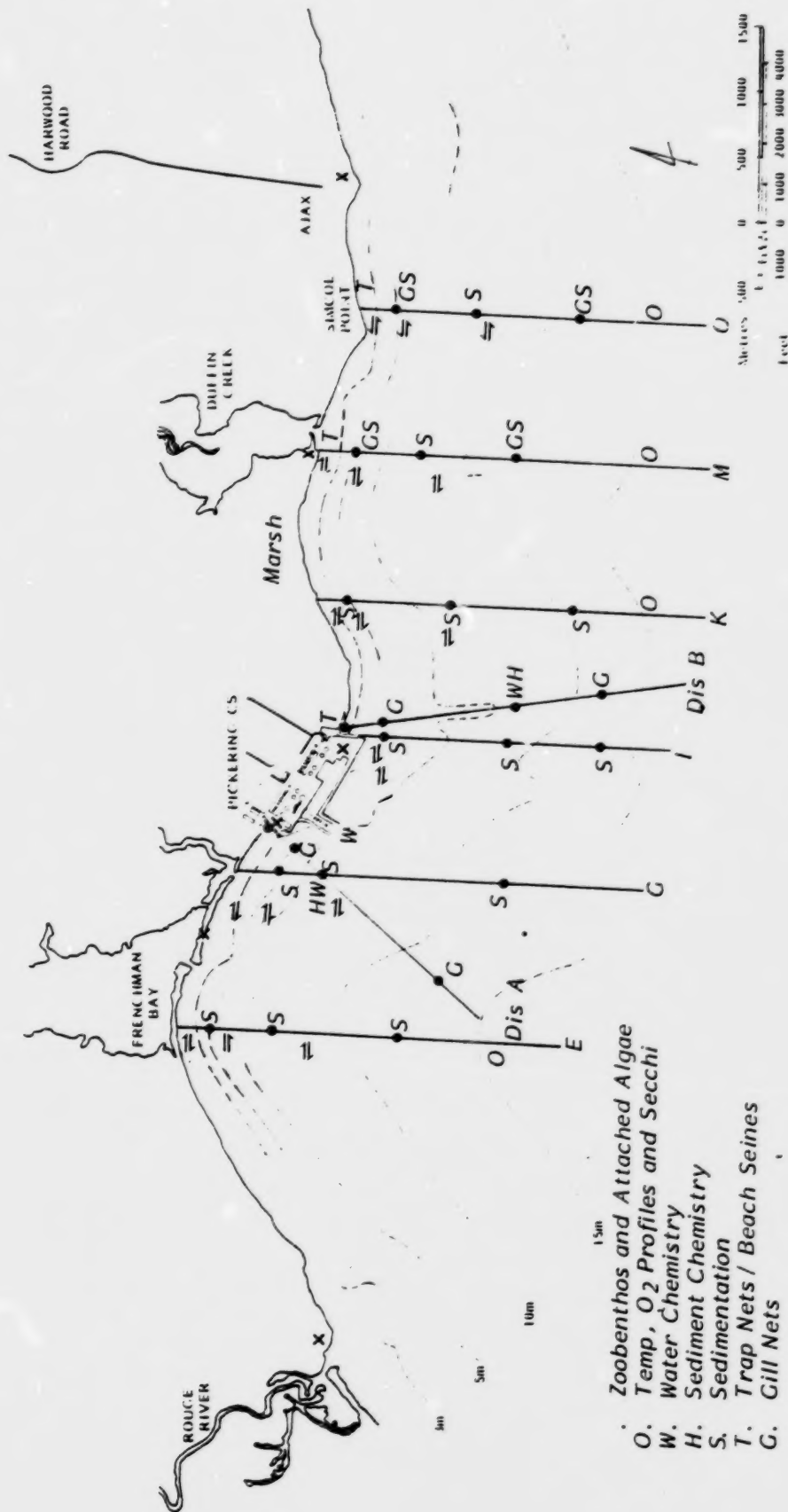


FIGURE 1.3-1
PICKERING CS 'B' PREOPERATIONAL STUDY - SITE MAP
1981 - 1982 SAMPLING LOCATIONS

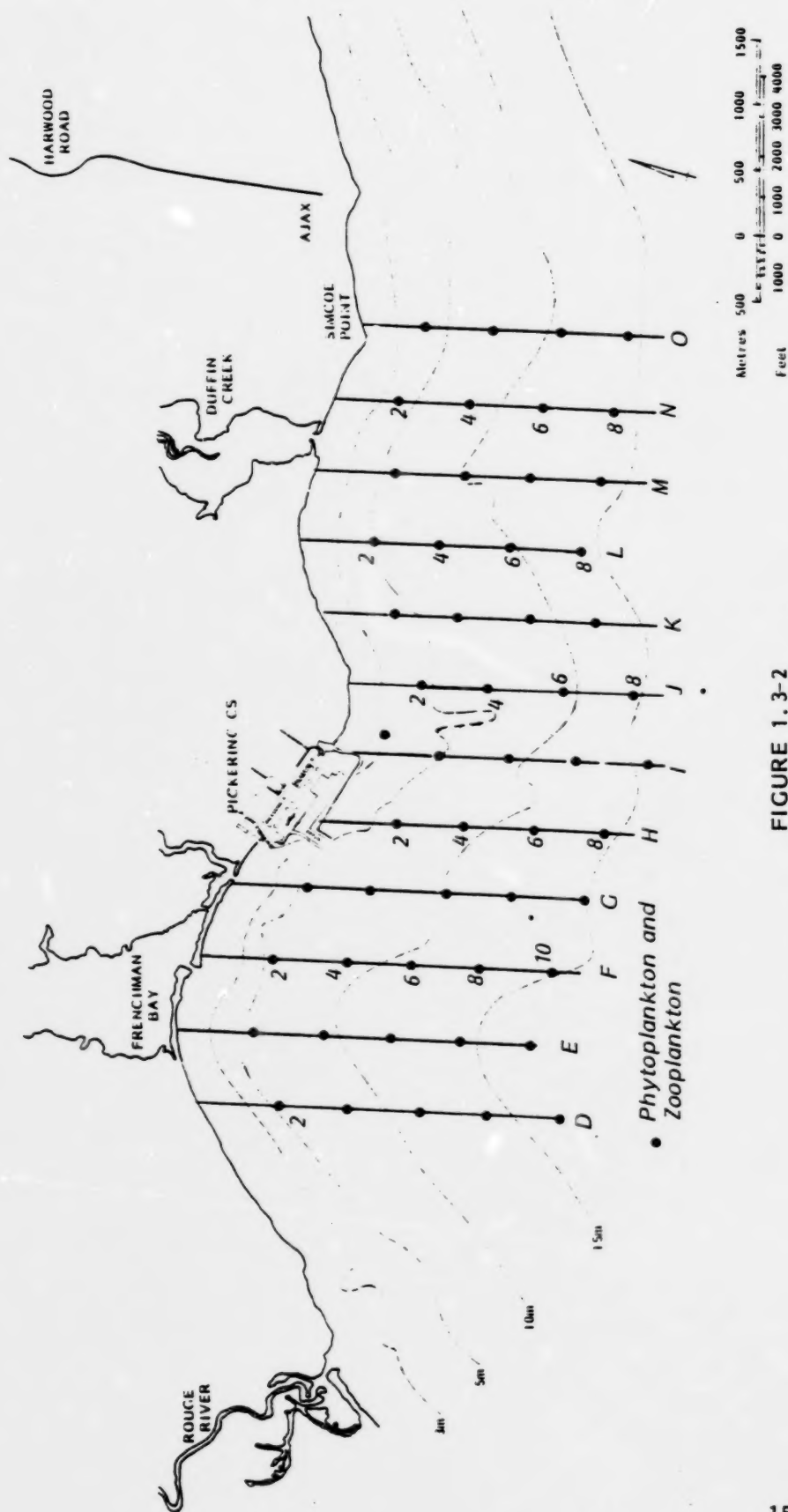


FIGURE 1.3-2
LOCATION OF PLANKTON GRID SAMPLING POINTS
PICKERING GS 'B' PREOPERATIONAL STUDY 1981-1982

2.1 Physical Characteristics

2.1.1 Sedimentation

Sets of four sediment tubes (inner diameter = 5.1 cm, height = 63 cm) were placed at the 3, 7 and 12 m depths along Transects F, G, I, K, M and O, and were left for two three-month intervals: May to August, and August to November. The sediment traps were retrieved by SCUBA equipped divers who capped the tubes prior to recovery. Samples were preserved by freezing. Following a thawing and settling period, the contents of the tubes were oven dried at 105°C to constant weight to determine dry weight and ashed for two hours at 525°C to determine the organic content expressed as loss on ignition (LOI).

2.1.2 Temperature and Dissolved Oxygen Profiles, and Water Transparency

Monthly vertical temperature and dissolved oxygen profiles (1 m intervals) were recorded at the 15 m spars on Transects E, G, I, K, M and O with the use of a calibrated (against air) temperature - oxygen metre (Hydrolab Model 2000). Water clarity was recorded as Secchi depths at the same time temperature and oxygen profiles were taken.

2.1.3 Mean Daily Temperatures

Mean daily temperatures from the Pickering GS 'A' intake forebay and the 3 m locations in the Pickering GS 'A' and 'B' discharges were recorded by Hydraulic Studies and Development Department of Design and Development Division using continuous monitoring equipment.

2.2 Water and Sediment Quality

2.2.1 Water Chemistry

Water samples for chemical analyses were collected four times (May, July, September and November) in the year at the mouth of the intake channel and the 7 m spars on the Pickering GS 'A' and 'B' discharge transects using a Van Dorn bottle. Samples were analyzed for the parameters listed in Table 2.2.1-1. Analyses were performed by Analytical Services Section of Research Division. Analytical Methods are described in Appendix I.

2.2.2 Sediment Chemistry

Sediment samples for heavy metal analyses (Table 2.2.1-1) were collected in sediment tubes placed at the 7 m locations on the Pickering GS 'A' and 'B' discharge transects for two three-month periods: May to August, and August to November. Chemical analyses of sediment samples were also performed by Analytical Services Section.

TABLE 2.2.1-1

Water and Sediment Variables
Analyzed - 1981

Water Quality Variables

Sediment
Quality Variables

Specific conductance
Turbidity
Suspended Solids (nonfilterable residue) 105°C
Suspended Solids (nonfilterable residue) 550°C
Dissolved Solids (filterable residue) 105°C
Dissolved Solids (filterable residue) 550°C
Total Organic Carbon
Total Hardness
Total Alkalinity
pH
Total Phosphorus
Orthophosphorus
Nitrate
Kjeldahl Nitrogen
Ammonia
Total Silica
Dissolved Silica
Chemical Oxygen Demand
Chlorophyll a
Oil and Grease
BOD
Sodium
Potassium
Calcium
Magnesium
Chloride
Sulphate
Phenols
Iron
Manganese
Lead
Copper
Zinc
Arsenic
Beryllium
Cadmium
Chromium
Cobalt
Mercury
Selenium
Nickel
Silver
Vanadium

Iron
Manganese
Lead
Copper
Zinc
Arsenic
Beryllium
Cadmium
Chromium
Cobalt
Mercury
Selenium
Nickel
Silver
Vanadium

2.3 Attached Algae

Per cent algal cover in the study area was determined in July, August and November and is presented on distribution maps. The data were collected by SCUBA equipped divers at the 1, 3, 7 and 12 m depths along Transects E, G, I, K, M, O and the Pickering GS 'A' and 'B' discharge transects.

2.4 Phytoplankton

Phytoplankton samples were collected on May 21, August 6 and November 25 at points 0.5, 1.0, 1.5, 2.0 and 2.5 km offshore along Transects D to O. Integrated water samples were taken with a non-metallic 3 m tube, and samples were preserved in Lugol's Iodine Solution. Data is presented as biomass in mg/m^3 .

Each time a set of grid samples was collected, three samples were taken at Spar K2 (Figure 1.3-2) such that an estimate of sampling error could be obtained (Appendix II). The standard deviations of the densities of taxa present in the replicates were calculated, and multiples of the standard deviation were then used to establish density categories, which were plotted on a map of the study area.

2.5 Zooplankton

Zooplankton samples were collected on May 21, August 6 and October 5 and were taken at the same locations as phytoplankton samples. Samples consisted of two surface hauls taken with a 27 L Schindler-Patalas trap. The trap was equipped with a 64 μm mesh net. Samples were preserved in alcohol which was replaced with 10% formalin in the laboratory. Data are presented as densities in numbers/ m^3 .

Again, triplicate samples were collected at Spar K2 (1.0 km offshore) and the estimated standard deviations (Appendix III) of the densities of the zooplankton were taken into account in constructing density distribution maps for dominant taxa.

2.6 Zoobenthos

Zoobenthos samples were collected at three different times of the year (June, August and October) at the 1, 3, 7 and 12 m spars along Transects E, G, I, K, M, O and the Pickering GS 'A' and 'B' discharge transects. Triplicate samples were collected with a small vacuum dredge (inner diameter = 11.4 cm) operated by SCUBA equipped divers and were preserved in 10% formalin. All samples were passed through a 250 μm mesh sieve and sorted. Data were presented as numbers/ m^2 .

Mutual information analysis was used to identify the spatial distribution and seasonal occurrence of zoobenthos assemblages.

2.7 Fish

Larval fish were collected bi-weekly from May through August (8 times). A duplicate five-minute surface tow was made parallel to shore along the 1, 3 and 7 m depth contours starting on Transects E, G, I, K, M and O (Figure 1.3-2). In addition, two surface tows were taken in the intake forebay. Sampling was initiated at dusk. Tows were made using a set of two 0.5 m (diameter) conical nets with mesh size of 361 μm . The average volume of water filtered per net during a five minute tow was 55 m^3 . Samples were preserved in 5% formalin. Data are presented as densities in numbers per 1000 m^3 .

Fish were collected monthly from May to November by beach seines and trap nets and from May to December by gill nets. Locations fished were the Pickering GS 'A' discharge area, the Pickering GS 'B' discharge location, Duffin Creek and Simcoe Point. Three beach seine hauls were made near shore at each location. Pairs of 1.2 m trap nets were set for two consecutive nights per month at the 3 m depth in the four areas. Sets of experimental gill nets were also set for two consecutive nights per month. Nets were set perpendicular to shore; one at the 3 to 5 m depth contours and a second at the 12 to 15 m depth. Experimental gill nets consisted of nine 15 m panels with mesh size ranging from 2.5 to 12.5 cm (1.3 cm increments). All fish caught were speciated, counted and examined externally for spawning condition, lamprey scars and disease. Data are presented as monthly catch per unit effort, the mean number of fish caught per net per month. Impingement data discussed were obtained from the Radioactivity Management and Environmental Protection Department of Nuclear Generation Division.

Larval Whitefish Study

Larval fish tows for Whitefish were conducted weekly from April 10 to May 14 (six times) to determine larval fish abundance and distribution in the Pickering GS area. The nine lake transects sampled were: Rouge River, Frenchman Bay, Pickering GS 'A' discharge, Pickering GS 'B' discharge location, East of Moore Point, Duffin Creek, Simcoe Point, Whitby East and Whitby West. Two five-minute surface tows were made parallel to shore along the 1 and 7 m depth contours at these transects. In addition, two five-minute bottom tows were taken at the 7 m depth contour of the transects. Surface zooplankton samples were collected in each sampling week at the 1 and 7 m contour, and from mid-depth and bottom at the 7 m contour at Whitby East. An additional sample was collected in Frenchman Bay.

Zooplankton samples were stored for analysis at a future date at the request of Design and Development Division.

2.8 Winter Waterfowl

Observations of waterfowl and other water-associated birds were made at several sites in the Pickering area. Observations were made on or near the first and fifteenth day of each month beginning September 25, 1981 and concluding April 8, 1982. The locations from which observations were made were:

- 1) the mouth of the Rouge River (marsh, river, Lake Ontario)
- 2) the mouth of Frenchman Bay (Lake Ontario)
- 3) the Pickering GS 'A' discharge and intake groins (Lake Ontario)
- 4) the Pickering GS 'B' discharge location (Lake Ontario)
- 5) the mouth of Duffin Creek (marsh, creek, Lake Ontario)
- 6) in Ajax at the foot of Harwood Rd. (Lake Ontario)

At each location on each date the number and species of ducks, gulls and shorebirds were recorded for six ten-minute intervals. Binoculars and spotting scopes (Bushnell Spacemaster Prismatic Telescope, 20x60) were utilized during the observation periods.

A distinction was made between birds associated with the site (ie, those lighted or hovering in the observation area) and those flying by. For each bird or group of birds, behaviour was recorded and their location in the study area mapped. Observations were conducted simultaneously at two locations and the chronological order of observation at each pair of sites was altered on each visit. All observations were conducted between 09:00 h to 15:00 h.

3.0 RESULTS

3.1 Physical Characteristics

3.1.1 Sedimentation

The weight of sediments deposited per cm^2 per day for the periods of May 8 to August 12 and August 14 to November 4 are shown in Figure 3.1.1-1 and the data are listed in Appendix IV. The sedimentation discussed in this section does not represent net sedimentation rate since the traps reduce resuspension of the sediment. Generally, the greatest amount of sediment was collected at the nearshore (3 m) locations, with quantities diminishing with increasing depth. Exceptions to the above were the 7 m location on the transect around the Pickering GS 'A' discharge (G) during the May to August period, and the 12 m

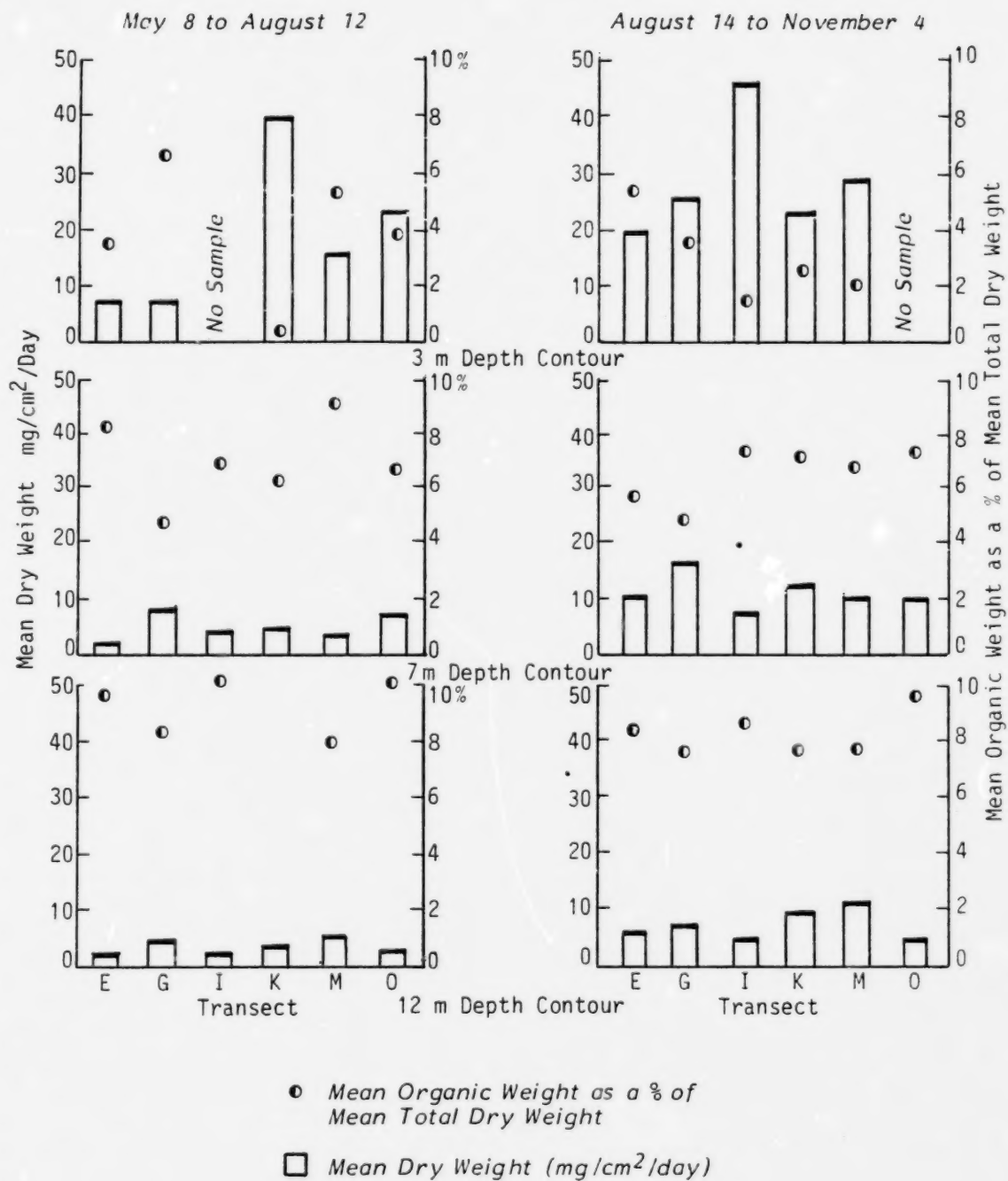


FIGURE 3.1.1-1
MEAN TOTAL DRY WEIGHT, AND PERCENT LOSS ON IGNITION OF
SEDIMENT COLLECTED IN TUBES - PICKERING GS 'B', 1981

location on the Duffin Creek transect (M) during the August to November period. Transect K (1 km east of Pickering GS 'B' discharge) had the greatest sedimentation rate at the 3 m depth during the May to August period while Transect I (near the Pickering GS 'B' discharge location) had the highest rate during the August to November period. The high rate at this location during this period was probably related to dredging activities at the Pickering GS 'B' discharge location. At the 7 and 12 m depths variation between transects was relative low.

During both the summer and fall sampling periods, the per cent loss on ignition, as an indication of organic content of the sediment, increased with increasing spar depth. Thus at 3 m the loss on ignition ranged from 0.3 to 6.6 in the summer and from 1.5 to 5.2 in the fall. At 7 m it ranged from 4.7 to 8.9 and 4.8 to 7.1 in the summer and fall, respectively, and at 12 m it ranged from 7.9 to 10.0 and 7.7 to 9.3, respectively. This indicates that there is a larger portion of organic material available as food to benthic organisms at the deeper depths where they were found in higher numbers. Both density and species richness of the benthos were higher at 7 and 12 m than at 3 m (see Section 3.6). No alongshore trends were obvious in the per cent loss on ignition of the sediment samples.

The dredging of the Pickering GS 'B' discharge channel may have contributed to the high sedimentation values obtained in the latter portion of the year, however, sedimentation rates were also found to be higher in the fall than in the summer in the previous two years of this study (OHRD Report Nos 82-266-K and 82-460-K) and this was attributed to the increase in fall storm activity.

3.1.2 Water Temperature and Dissolved Oxygen Profiles and Secchi Depths

Vertical profiles of water temperature, dissolved oxygen levels and water transparency were recorded monthly at 1 m intervals to a depth of 15 m at the six survey transects from May to December (Appendix V). Temperatures during monthly sampling periods varied only slightly (maximum mean temperature difference between transects was 1.1°C in June), with the highest temperatures recorded in the surface waters of the transects in the immediate vicinity (Transects E and G) of the Pickering GS 'A' discharge. Maximum vertical temperature difference was 10.1°C at Transect E on August 21. Beginning in September, the water column was virtually isothermal across the study site on each of the sampling dates to December. Formation of a thermocline was not apparent on any of the dates that temperature profiles were recorded.

The dissolved oxygen levels in the water column were generally homogeneous and remained at or above saturation levels throughout the study area.

Water transparency recordings were made at the same time and location as were the water temperature and dissolved oxygen profiles. Secchi depth readings ranged from 0.5 m on July 29 at Transect E to 5.5 m on November 17 at Transect M. Differences between locations were usually less than 33% and were not consistent through time.

3.1.3 Mean Daily Temperatures

Mean daily temperatures at the 3 m locations in the Pickering GS 'A' discharge and around the Pickering GS 'B' discharge location (locations TH66 and THB01, respectively) were obtained from Hydraulic Studies and Development Department of Design and Development Division.

The water temperature at the above two locations fluctuated considerably (Figure 3.1.3-1). Generally, gradual warming occurred between mid-March and late June while steeper increases were observed in July and the first week of August. Maximum mean daily temperatures recorded at the 3 m depth in the area of the Pickering GS 'B' discharge location was 21.2°C (August 22), and at the 3 m depth at the Pickering GS 'A' discharge 31.2°C on September 2. At the Pickering GS 'B' discharge location, temperatures remained below 8.5°C following a rapid decline in temperature in late October. During the May to December study period major upwellings, identified by sudden large drops in temperature, occurred in late May, mid and late June, mid-July, mid-September and early October.

According to the temperatures recorded at the 3 m location in the Pickering GS 'A' discharge, mean monthly temperatures were highest in August (Table 3.1.3-1). Excluding September and December when temperatures were not obtained for the Pickering GS 'B' discharge location, the differences between monthly temperatures (overlapping dates only) at the Pickering GS 'A' and 'B' discharge locations ranged from 7.9 in November to 11.3°C in January. These differences are not based on mean monthly temperatures but are based on temperatures obtained on days when temperatures were recorded at both locations. The differences in temperatures were mainly due to the operation of Pickering GS 'A' with some natural variation.

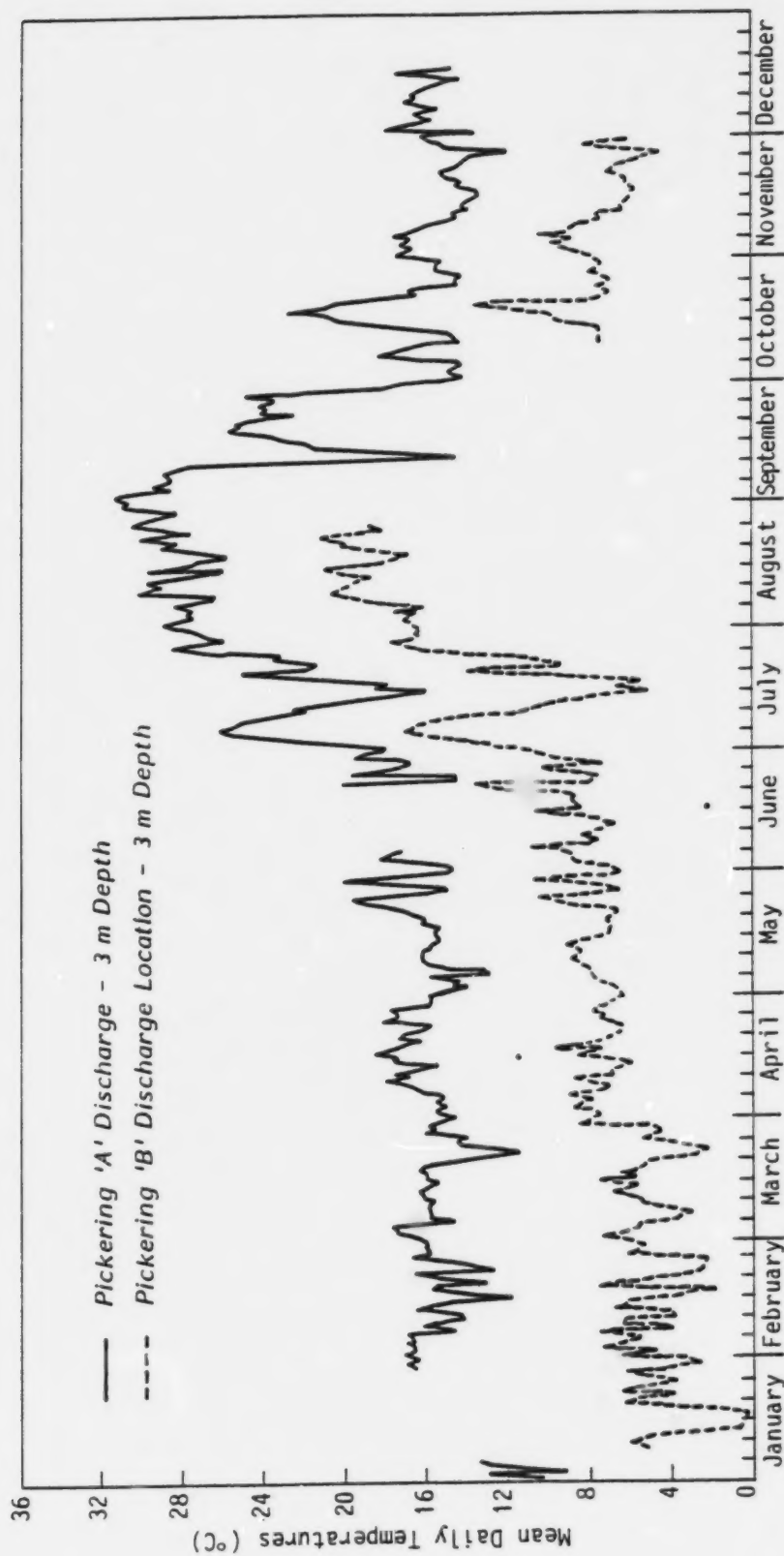


FIGURE 3.1.3-1
MEAN DAILY TEMPERATURES AT THE 3 m DEPTH IN THE AREA OF THE PICKERING 'A' DISCHARGE
(TH66) AND THE PICKERING 'B' DISCHARGE LOCATION (THB01) IN 1981

TABLE 3.1.3-1

Monthly Temperatures (°C) at the 3 m Depth in the Areas of
the Pickering GS 'A' Discharge and Pickering GS 'B' Discharge
Location and Monthly Temperature Difference Between
the Two Locations - 1981

	A Pickering GS 'A' Discharge Location - 3 m	B Pickering GS 'B' Discharge Location - 3 m	Difference Between Mean Monthly Temperatures at Locations A and B*
January	13.6 ¹	3.9 ²	11.3
February	15.3	5.1	10.2
March	15.3	5.4	9.9
April	16.7	7.5	8.5
May	16.0	7.9	8.1
June	17.2 ³	9.0	8.1
July	22.9	12.7	10.3
August	28.4	19.0 ⁴	9.1
September	24.1	-	-
October	16.7	8.5 ⁵	8.4
November	15.2	7.3	7.9
December	16.2	-	-

* Overlapping dates only

1 Excluding Jan 6 - 28

2 Excluding Jan 4 - 7

3 Excluding June 6 - 21

4 Excluding Aug 26 - 31

5 Excluding Oct 1 - 8

3.2 Water and Sediment Quality

3.2.1 Water Chemistry

Surface water samples were collected in the intake and at the 7 m spars in the Pickering GS 'A' discharge and at the Pickering GS 'B' discharge location on May 13, July 23, September 30 and November 30, 1981. Water quality data are presented in Tables 3.2.1-1 and 3.2.1-2.

As in 1979 (Ontario Hydro Research Division Report No 82-266-K) no consistent spatial trends were obvious in the levels of the water chemistry parameters monitored although some seasonal differences were encountered for some variables.

Specific conductance (the reciprocal of the resistance measured between two electrodes separated by 1 cm and housing a cross-section of 1 cm²) gives a measure of the total amount of ionized materials in the water. In our study area specific conductance varied little both spatially and seasonally and ranged between 29 and 33 mS/m indicating that total ionic content did not vary much. Levels of individual ions of importance to primary producers are discussed later on in this section.

Turbidity describes the degree of opaqueness produced in water by suspended particulate matter. Materials creating turbid conditions include humus, silt, organic detritus, colloidal matter and plankton. Turbidity in our study ranged between 1.0 and 7.0 NTU with lowest mean turbidity found on July 23, and highest turbidity on November 30. High turbidity on November 30 may have been related to fall turnover or increased storm activity. In contrast to the turbidity measurements, Secchi depth was found to be lowest on July 29 and highest on November 15. However, turbidity was measured in surface samples collected at the 7 m depth while Secchi depth was determined further offshore at the 15 m depth. Spatially, turbidity varied little although in both September and November it was highest at the Pickering GS 'A' discharge.

Levels of suspended solids which includes particulate organic (seston) and colloidal inorganic substances ranged from <1 to 7.6 mg/L. The levels were lower in July and September, when suspended solids were either not detectable or occurred in levels near the detection levels, than in May and November. This was consistent with the seasonal changes in the turbidity levels and may have been related to spring runoff in May and to fall turnover in November. No consistent spatial trends were obvious although the levels of suspended solids were higher in

TABLE 3.2.1-1

CONCENTRATIONS OF WATER CHEMISTRY PARAMETERS IN WATER SAMPLES COLLECTED AT THE MOUTH OF THE INTAKE AND AT THE 7 m SPARS IN THE PICKERING GS 'A' DISCHARGE AND PICKERING GS 'B' DISCHARGE LOCATION AREA - 1981

Parameter	Unit	May 13, 1981			July 23, 1981			September 30, 1981			November 30, 1981		
		Intake	'A' Disch 7 m spar	'B' Disch Location 7 m spar	Intake	'A' Disch 7 m spar	'B' Disch Location 7 m spar	Intake	'A' Disch 7 m spar	'B' Disch Location 7 m spar	Intake	'A' Disch 7 m spar	'B' Disch Location 7 m spar
Specific Conductance	mS/m	33	3.6	33	29	30	30	33	33	33	31	31	30
Turbidity	NTU	3.6	3.6	3.6	1.0	1.0	1.0	1.2	1.3	1.1	7.6	7.8	6.5
Suspended Solids 105°C	mg/L	5.3	6.4	1.8	<1	<1	<1	1.6	1.2	1.6	7.6	2.4	5.8
Suspended Solids 550°C	mg/L	5.0	6.0	0.6	<1	<1	<1	<1	1.2	1.2	6.2	1.8	4.8
Dissolved Solids 105°C	mg/L	223	223	214	204	215	265	208	200	204	210	220	220
Dissolved Solids 550°C	mg/L	166	168	168	167	167	201	154	156	154	160	170	160
Total Organic Carbon	mg/L	0.9	<0.5	<0.5	2.2	2.2	2.2	154	156	154	<0.5	<0.5	<0.5
Total Inorganic Carbon	mg/L	25	25	25	20	20	20	25	25	25	25	25	24
Total Hardness as CaCO ₃	mg/L	125	125	123	130	130	130	128	128	128	130	133	128
Total Alkalinity as CaCO ₃ , HCO ₃ ⁻	mg/L	97	97	95	91	91	91	93	93	94	96	96	95
pH		8.3	8.3	8.3	8.3	8.3	8.3	7.8	7.8	7.8	8.2	8.4	8.4
Total Phosphorus (P)	µg/L	10	12	8	21	16	11	8	10	9	27	20	23
Orthophosphorus (P)	µg/L	11	12	8	7	5	<5	8	<5	<5	11	9	9
Nitrate (NO ₃)	mg/L	1.5	1.5	1.5	0.9	1.0	0.9	2.0	2.0	2.0	2.0	2.0	1.8
Kjeldahl Nitrogen	mg/L	1.3	1.5	0.9	0.4	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.4
Ammonia (NH ₃)	mg/L	<0.01	0.03	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Silica (SiO ₂)	mg/L	1.3	0.7	0.4	2.5	4.1	1.5	1.3	1.0	1.2	1.5	1.1	1.4
Dissolved Silica (SiO ₂)	mg/L	0.4	0.3	0.2	1.4	1.6	1.2	0.9	0.9	0.9	0.4	0.5	0.6
Chemical Oxygen Demand	mg/L	8	7	7	<5	8	7	18	13	5	<5	6	<5
Chlorophyll a	µg/L	1.8	3.6	2.5		no samples		0.6	1.0	0.9	0.5	0.5	0.5

TABLE 3.2.1-2

CONCENTRATIONS OF HYDROCARBONS AND METALS IN UNFILTERED WATER SAMPLES COLLECTED AT THE MOUTH OF THE INTAKE AND AT THE 7 m SPARS IN THE PICKERING GS 'A' AND PICKERING 'B' DISCHARGE LOCATION AREAS - 1981

Parameter	Unit	May 13, 1981			July 23, 1981			September 30, 1981			November 30, 1981		
		Intake	'A' Disch 7 m spar	'B' Disch Location 7 m spar	Intake	'A' Disch 7 m spar	'B' Disch Location 7 m spar	Intake	'A' Disch 7 m spar	'B' Disch Location 7 m spar	Intake	'A' Disch 7 m spar	'B' Disch Location 7 m spar
Oil and Grease	mg/L	0.20	0.10	0.20	0.10	0.14	0.09	0.15	0.08	0.34	0.09	0.12	0.08
BOD	mg/L	1	1	1	2.1	2.1	2.2	2.0	1.8	1.7	1.4	1.3	2.2
Sodium	mg/L	12.9	13.0	12.6	12	12	12	12	12	12	12	12	12
Potassium	mg/L	1.5	1.5	1.4	1.4	1.7	1.4	1.4	1.4	1.4	1.2	1.2	1.2
Calcium	mg/L	37	37	37	39	39	39	38	38	38	39	40	39
Magnesium	mg/L	8	8	8	8.1	8.0	8.1	7.9	8.0	8.0	7.8	8.2	7.8
Chloride	mg/L	27	27	26	27	26	26	30	26	25	27	28	27
Sulphate	mg/L	27	35	28	28	27	27	32	28	28	26	27	27
Phenols	µg/L	2	<2	<2	6	6	6	8	3	7	<6	<6	<6
Iron	mg/L	0.10	0.11	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.18	0.18	0.15
Manganese	mg/L	<0.2	<0.2	<0.2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead	µg/L	<2	<2	<2	<5	<5	<5	<2	<2	<2	<2	<2	<2
Copper	µg/L	5	4	4	10	10	7	3	5	1	12	7	3
Zinc	mg/L	<0.2	<0.2	<0.2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Arsenic	µg/L	3	3	3	<1	1	<1	<1	2	<1	1	1	1
Beryllium	µg/L	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1
Cadmium	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	mg/L	<0.5	<0.5	<0.5	<0.1	<0.1	<0.1	<0.05	<0.05	<0.05	<0.1	<0.1	<0.1
Cobalt	mg/L	<0.5	<0.5	<0.5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cobalt	mg/L	<0.4	<0.4	<0.4	<0.2	0.2	<0.2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	1
Selenium	µg/L	4	4	4	<5	<5	<5	<5	<5	<5	<5	<5	<5
Nickel	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1.7	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	µg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Vanadium	µg/L												

the Pickering GS 'A' discharge in May and at the intake in November. In May and November, the loss on ignition, as a measure of organic content of the suspended solids, ranged from 6 to 67%. No spatial trends were obvious in the loss on ignition of the suspended solids with highest loss on ignition found at the Pickering GS 'B' discharge location in May and at the Pickering GS 'A' discharge in November.

No spatial or seasonal trends were obvious in the levels of dissolved solids which ranged between 200 and 225 mg/L in all samples except the July Pickering GS 'B' discharge location sample in which the concentration was 265 mg/L. The total dissolved solids levels of the water describes the chemical density of the environment which governs the osmoregulation of plants and animals. Osmoregulation is a main process which limits aquatic organisms to their respective habitats (Reid 1961). Dissolved solids also include nutritionally important ions for primary producers as well as other dissolved substances directly required by some animals. Thus the chemical density of the aquatic environment did not differ spatially or seasonally.

The mean loss on ignition of the dissolved solids was approximately 24% on each sampling date. Rivers and lakes in Ontario, free of industrial waste, normally have a dissolved solids concentration equal to 0.65 ± 1.0 times the specific conductance of the water in micromhos/cm (MOE, 1981). With the exception of the July 23 Pickering GS 'B' discharge location sample, the ratio of dissolved solids to conductivity were within this range.

The water in the study area was moderately basic with pH ranging between 7.8 and 8.4. Hardness, reported in terms of CaCO_3 ranged between 125 and 133 with lowest levels found in May. Alkalinity, reported in terms of HCO_3^- as CaCO_3 , was lowest in July and ranged from 91 to 97 mg/L.

The chemical oxygen demand (COD), a measure of the oxygen required for the oxidation of susceptible organic and inorganic compounds under vigorous chemical oxidation conditions, was between <5 to 8 mg/L in all samples except the September intake (18 mg/L) and Pickering GS 'A' discharge (13 mg/L) samples.

Samples for organic and inorganic carbon determinations collected on September 30 were destroyed and the data are therefore not available. Total organic carbon, the carbon source available to primary producers for photosynthesis, was found in highest levels on July 23 (2.2 mg/L). Organic carbon was not detected in any of the remaining samples except for the May 13 intake sample (0.9 mg/L). Inorganic carbon which consists mainly of humic substances and partly degraded plant and animal materials ranged from 20 to 25 mg/L with lowest levels found on July 23.

No spatial trends were obvious in the concentrations of phosphorus, nitrogen, silica and chlorophyll a. Phosphorus is an essential nutrient for primary production and is often the limiting factor for primary production in large lakes (Russell-Hunter 1970). Phosphorus concentrations (measured as $\mu\text{g P/L}$) which ranged from 8 to 27 $\mu\text{g/L}$ were highest in November. High phosphorus levels at this time were probably related to fall turnover. Orthophosphorus (measured as P), the primary form of phosphorous utilized by phytoplankton, occurred in levels from <5 to 12 $\mu\text{g/L}$ with higher levels found on May 13 and November 30 than on the remaining two dates.

Nitrate (NO_3), the form in which nitrogen is most easily assimilated by algae was found in levels ranging from 0.9 to 2.0 $\mu\text{g/L}$ with lowest levels in July. Kjeldahl nitrogen levels (organic nitrogen plus ammonia) were high on May 13 when the mean concentration was 1.2 mg/L. On the remaining dates levels were equal to or below 0.4 mg/L.

Ammonia (NH_3), a product of bacterial decomposition of protein and of deamination, was either not detected or found in levels at the detection limit of 0.01 mg/L in all samples except the May 13, Pickering GS 'A' discharge sample (0.03 mg/L). Ammonia levels in unpolluted waters are usually around 1 mg/L or less (Reid, 1961).

With the very low levels of ammonia, the Kjeldahl nitrogen concentrations are probably representative of the organic nitrogen levels. Levels of organic nitrogen between 0.7 and 1.2, as was found in May, are indicative of eutrophic conditions while levels between 0.2 and 0.4 mg/L, found on the remaining sampling occasions, are indicative of oligo-mesotrophic conditions (Wetzel, 1975).

The concentrations of total silica (SiO_2) were generally slightly higher in 1981 than they were in 1979. Total silica (SiO_2) levels were highest in July (2.7 mg/L) and lowest in May (0.8 mg/L). The total silica levels encountered at the Pickering GS 'A' discharge and the Pickering GS 'B' discharge location (0.7 and 0.4 mg/L) were within the range of 0.5 to 0.3 mg SiO_2/L considered to at least partially limit population development of such diatoms as *Asterionella*, *Melosira* and *Tabellaria* (Reid, 1961). Mean dissolved silica levels were also highest in July (1.4 mg/L) and lowest in May (0.3 mg/L). Higher silica levels in July were probably a result of the mid-July upwelling replenishing the surface waters with silica. Low silica levels in May are probably in part due to depletion following the spring diatom increase.

The July 23 samples for chlorophyll a analysis were destroyed and data is not available for this date. On the remaining dates the highest mean concentrations were found on May 13 (3.6 µg/L) and lowest on November 30 (0.5 µg/L). The chlorophyll a levels were below the levels that Dobson et al (1974) considered to be a mesotrophic range (4.4 - 8.8 µg/L).

Phenols ranged in concentrations of <2 to 8 µg/L. Pickering NGS does not emit phenols (Memorandum to C.D. Burnham, February 25, 1983, R.A. Hester). In the first year of the Pickering GS 'B' preoperational study performed in 1979 (Ontario Hydro Research Division Report No 82-266-K) phenol, if present, was present in levels below the detection limit of 4.0 µg/L on each sampling date.

Chloride levels were found to be low ranging from 25 to 30 mg/L. Sulphates, the form in which sulfur necessary in protein metabolism is supplied to organisms, was found in low concentrations ranging from 26 to 32 mg/L.

Sodium and potassium levels were low on all four sampling dates with levels of 12 to 13 mg/L and 1.2 to 1.7, respectively. Calcium and magnesium levels were also low and varied little ranging between 37 and 40 mg/L and 7.8 to 8.2 mg/L, respectively.

Iron if present was below the detection limit (0.05 mg/L) at all locations on July 23 and September 30, as well as at the 'B' discharge location on May 13. On the remaining two dates it occurred in concentrations between 0.10 and 0.18 mg/L with higher levels found on November 30. Copper levels ranged from 1 to 12 µg/L with lower mean concentrations found on May 13 and September 30 than on the remaining two dates. Arsenic if present ranged from below the detection level of 1 µg/L to 3 µg/L. Selenium was only detectable (≥ 1 mg/L) on November 30 when a concentration of 1 mg/L was found at all three locations. Detectable nickel levels were only found on May 13 when a concentration of 4 µg/L was found at all locations. The silver concentration in the September intake sample of 1.7 µg/L was considered to be abberantly high since silver was not detected in any of the remaining samples (<0.2 µg/L) and the high estimate was attributed to sample contamination. The remaining elements monitored occurred in concentrations below their respective detection limits in all samples.

A comparison of levels of some of the parameters with MOE (1978; 1981) objectives for each parameter is presented in Table 3.2.1-3. Levels of phosphorus encountered in November (<20 µg/L) exceeded the MOE objective for the avoidance of nuisance concentrations of algae. However low temperatures encountered in November would preclude the rapid growth of algae

TABLE 3.2.1-3

Comparison of Levels of Detectable Water Chemistry Parameters in
the Pickering GS 'B' Study Area with MOE Objectives for Each Parameter

Parameter	Range	MOE Objective	Comment
Phosphorus	8 - 27 µg/L	<20 µg/L	To avoid nuisance concentrations of algae
Ammonia	<0.01 - 0.03 mg/L	<0.02 mg/L	For the protection of aquatic organisms
Phenols	<2 - 8 µg/L	<1 µg/L	To protect against tainting of edible fish
Chloride	25 - 30 mg/L	<250 mg/L	Maximum allowable level for domestic water supply
Sulphate	26 - 32 mg/L	<250 mg/L	Maximum allowable level for domestic water supply
Iron	<0.05 - 0.18 mg/L	<0.3 mg/L	For the protection of aquatic life
Copper	1 - 12 µg/L	<5 µg/L	For the protection of aquatic life
Arsenic	<1 - 3 µg/L	<100 µg/L	For the protection of aquatic life
Selenium	<1 -1 µg/L	<0.1 mg/L	For the protection of aquatic life
Nickel	4 µg/L	<25 µg/L	For the protection of aquatic life

at that time. The ammonia levels in the Pickering GS 'A' discharge on May 13 (0.03 µg/L) exceeded the MOE objective for the protection of aquatic organisms. The objective for phenol are levels equal to or less than 1 µg/L to protect against tainting of edible fish flesh. Unfortunately, analytical detection levels were generally greater than the recommended limit such that all detectable levels were higher than the limit. Chloride and sulphate levels were below their recommended limits for the protection of aquatic life. Copper levels exceeded the MOE objective (5 µg/L) for the protection of aquatic life.

Levels and ratios of most of the water quality parameters measured indicate that the water in the study area is generally good and fits Dobson et al's (1974) description of the central basin of Lake Ontario as exhibiting eutrophic symptoms but as generally being mesotrophic in character.

3.2.2 Sediment Chemistry

The concentrations of metals in sediment accumulated in traps placed at the Pickering GS 'A' discharge and Pickering GS 'B' discharge location from May to August and August to November, as well as in sediment collected in November with a grab sampler from areas immediately adjacent to the traps, are presented in Table 3.2.2-1.

The sediment traps reduce resuspension of seston and sediment accumulated over a four month period while the grab samples have been exposed to the transportation and mixing of sediment caused by water currents and provide a true sediment sample. Differences in the levels of some metals in the two types of samples are at least in part due to the difference in the collection methods.

The surficial sediment components analyzed together made up a maximum of 3.2% of the sediment by weight. Iron was the main constituent making up substantially higher proportions of the weight of the sediment than the remaining elements listed. Iron was one of only five metals found in detectable levels at the surface of the water column. Its weight ranged from 16 000 to 30 000 mg/kg. Manganese was the second largest contributor to the weight of the sediment contributing from 371 to 468 mg/kg.

Since data on the background conditions of the elements in the surficial sediments around Pickering GS is lacking, the levels of the metals in the grab samples were compared to the ranges used by MOE (1976) to classify sediments from Great Lakes harbours. Copper, zinc, chromium, lead, cadmium, cobalt, mercury, silver and nickel levels were found in levels within MOE's unpolluted range. Manganese levels were in the moderately polluted range. The arsenic level at the Pickering GS 'A'

TABLE 3.2.2-1

HEAVY METAL CONCENTRATIONS (mg/kg) IN SEDIMENT SAMPLES COLLECTED AT
7 m SPARS AT PICKERING GS 'A' DISCHARGE AND PICKERING GS 'B' DISCHARGE LOCATION - 1981

Element (mg/kg)	May - August Sediment Trap Samples		August - November Sediment Trap Samples		November Grab Samples	
	Discharge 'A'	Discharge 'B'	Discharge 'A'	Discharge 'B'	Discharge 'A'	Discharge 'B'
	7 m	7 m	7 m	7 m	7 m	7 m
Iron (Fe)	16 000	18 300	16 950	18 975	19 600	30 800
Manganese (Mn)	434	468	423	444	371	426
Lead (Pb)	34	34	28	32	13	38
Copper (Cu)	40	40	42	38	9	20
Zinc (Zn)	95	118	88	97	29	61
Arsenic (As)	4.7	4.7	4.9	3.1	1.7	3.9
Beryllium (Be)	0.5	0.6	0.46	0.44	0.26	0.42
Cadmium (Cd)	4.1	4.1	3.5	2.5	2.5	2.5
Chromium (Cr)	31.0	40.0	32.0	32.8	10.0	21.0
Cobalt (Co)	10.3	10.5	10.0	11.0	8.0	14.0
Mercury (Hg)	0.8	0.4	0.8	0.7	0.1	0.2
Selenium (Se)	0.5	0.8	0.4	0.6	0.05	0.3
Nickel (Ni)	26	29	26	24	10	21
Silver (Ag)	0.2	0.3	0.22	0.2	0.2	0.15
Vanadium (V)	49	59	48	53	78	118

discharge was in the nonpolluted range and at the Pickering GS 'B' discharge location it was in the moderately polluted range. Iron levels at the Pickering GS 'A' discharge and Pickering GS 'B' discharge location were in the moderately and heavily polluted ranges, respectively. Levels of beryllium, selenium and vanadium for the classification of sediment were not available.

3.3 Attached Algae

The per cent cover of attached algae is mapped along the eight transects in Figure 3.3-1 for the three sampling periods July 6 to 8, August 10 to 13 and October 8 to 16, 1981. The positions of the sampling spars at the 1 m and 3 m depths in the Pickering GS 'B' discharge were moved 100 m east of the locations used in 1979 due to dredging activities. Similarly, the location of the 1 m depth in the Pickering GS 'A' discharge was moved slightly west of its original (1979) position in July due to strong currents.

No attached algae were observed on Transect E during any sampling period in 1981. This is consistent with observations made in 1979 (Ontario Hydro Research Division Report No 82-266-K) and is attributable to lack of suitable substrate along Transect E. Transect E has a sand substrate.

Other locations with no attached algae during any sampling period in 1981 include the 1 m depth along the easternmost transect (O), the 3 m depth along Transects G, and A, in the area of the Pickering GS 'A' discharge, and K and M, near Duffin Creek, as well as the 7 m depth along Transect M. The substrate at these locations in 1981 was also sand.

Attached algae were observed at the remaining sampling locations during at least one sampling period in 1981. Changes in algal cover between sampling periods at these locations could reflect either or both seasonal changes in algal abundance and small changes (a few meters) in spar location. The small changes in spar location are important in areas where substrate variability is high, since the portion of sand in the substrate (and consequently, the area suitable for algal growth) changes between sampling periods. Changes in attached algal cover in such locations reflect changes in the availability of suitable substrate more strongly than seasonal changes. For example, the percentages of non-sand substrates (gravel, pebble, cobble, boulder and armour stone) at the 3 m depth in the Pickering GS 'B' discharge were 25, 80 and 25% for the July, August and October sampling periods. The corresponding values for algal cover were 20, 80 and 25% indicating that all suitable substrate were covered by attached algae in August and October but not in July. To account for differences in substrate availability, the cover of

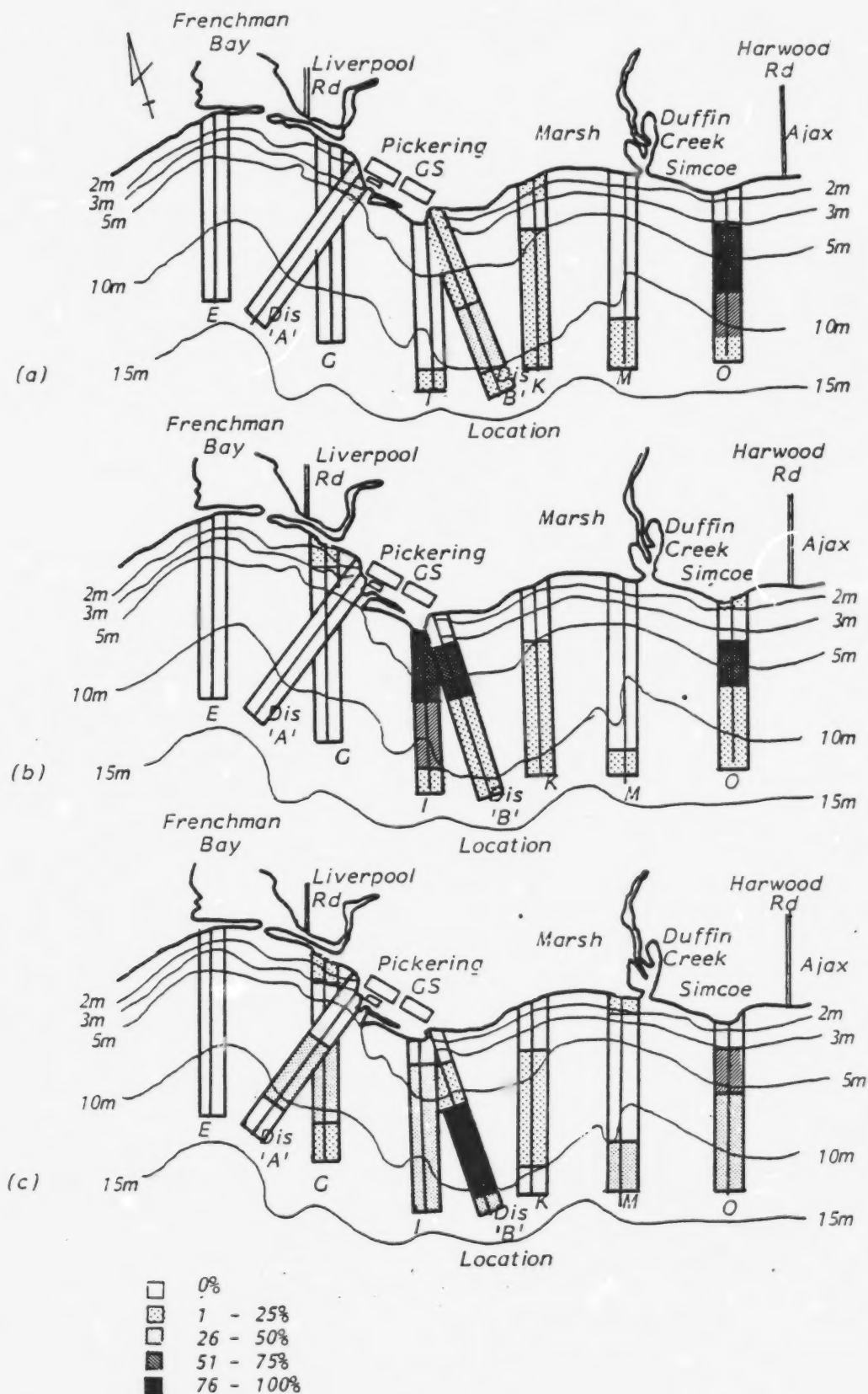


FIGURE 3.3-1

attached algae was expressed as a percentage of suitable substrate area for each sampling date and mapped in Figure 3.3-2. Data from visual observations of substrate composition are contained in Appendix VI. Figure 3.3-2 suggests that attached algal cover on suitable substrates was generally highest in the Pickering GS 'B' discharge and along Transect I, in the vicinity of the Pickering GS 'B' discharge. No distinct seasonal trends are apparent. This is in contrast to 1979 when highest cover values were reached in October.

3.4 Phytoplankton

Phytoplankton was sampled on May 21, August 6, and November 25. The species composition and mean density (mg/m³) of the individual taxa in the study area on these dates are presented in Table 3.4-1. Complete data are presented in Appendix VII.

In terms of biomass, the Bacillariophyta (diatoms) was the main phytoplankton group present on the spring sampling occasion, while the Pyrrophyta (flagellates) dominated on the summer and fall sampling dates. The flagellate *Cryptomonas* sp was the dominant phytoplankton taxa present on all three dates. Munawar and Nauwerck (1971) found a member of this taxa to be one of the prominent perennial species (*C. erosa*) in Lake Ontario. On May 21, *Cryptomonas* made up 30% of the phytoplankton biomass. The diatom *Melosira granulata*, a diatom generally found to be dominant in eutrophic lakes (Hutchinson 1967), was the second most abundant taxa present representing 23% of the total phytoplankton biomass. Other prominent taxa present on this day included the diatom *Tabellaria fenestrata* (8%) and the flagellate *Peridinium* (8%). *Cryptomonas* was highly dominant on August 6, accounting for 93% of the total biomass. *R. minuta* was the second most important taxa present (5%). Dense growth of cryptomonads is generally found during cold periods of the year under low light conditions (Wetzel 1975) common during the winter. A mid-July upwelling which resulted in cooler surface water temperatures for most of the remainder of the month of July may have created favorable environmental conditions for the proliferation of the cryptomonads at this time. Cryptomonads made up 65% of the total biomass on November 25. Important diatoms present on this day included *Tabellaria fenestrata* (16%) and *Asterionella gracillima* (8%). Mean total phytoplankton biomass was lowest on May 21 (760 mg/m³) and highest on August 6 (2 378 mg/m³).

May 21

On this day the surface water temperature in the study area ranged between 6.0°C and 16°C, with temperatures of 10°C and higher only found in the area immediately to the south and west of the Pickering GS 'A' discharge (Figure 3.4-1a).

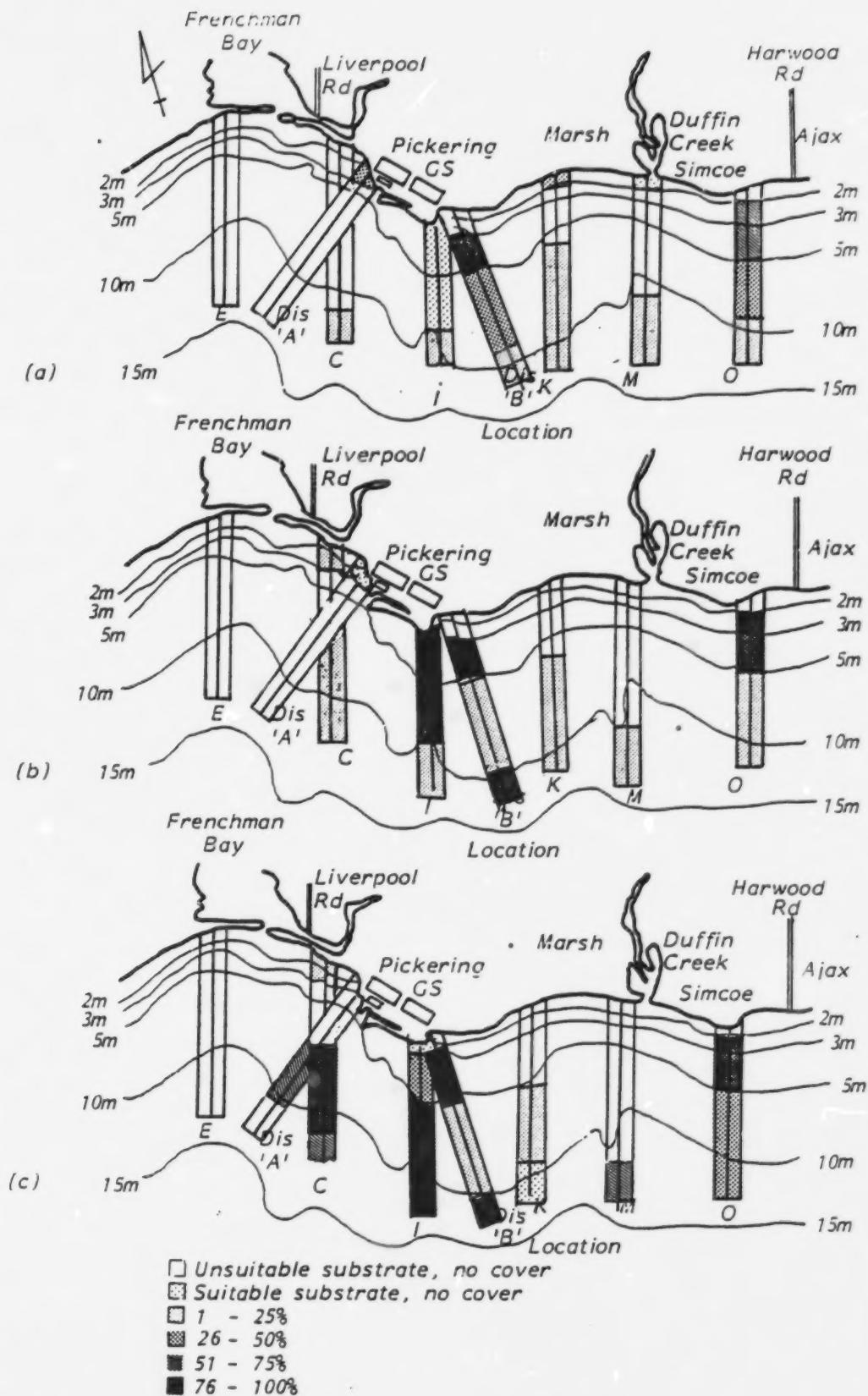


FIGURE 3.3-2

COVER OF ATTACHED ALGAE EXPRESSED AS A PERCENTAGE OF SUBSTRATE
SUITABLE FOR ALGAL GROWTH (a) JULY, (b) AUGUST, (c) OCTOBER
PICKERING GS 'B', 1981

TABLE 3.4-1

SPECIES COMPOSITION AND MEAN BIOMASS OF PHYTOPLANKTON
IN LAKE ONTARIO AT PICKERING GS 'B' - 1981

	May 21		August 6		November 25	
	%	Mean Biomass mg/m ³	%	Mean Biomass mg/m ³	%	Mean Biomass mg/m ³
Cyanophyta - Total		2.0		1.6		1.5
<u>Anabaena</u> sp			<0.1	1.5		
<u>Aphanizomenon flos-aque</u>	0.3	1.9	<0.1	<0.1	<0.1	0.5
<u>Croococcus</u> sp					<0.1	0.5
<u>Coelosphaerium</u> sp					<0.1	0.1
<u>Microcystis</u> sp			<0.1	0.1		
<u>Oscillatoria</u> spp	<0.1	0.1			<0.1	0.4
Chlorophyta - Total		7.0		11.7		12.9
<u>Actinastrum</u> sp	<0.1	0.1				
<u>Ankistrodesmus falcatus</u>	0.1	1.0	<0.1	0.3	<0.1	0.4
<u>Ankistrodesmus falcatus</u> var <u>mirabilis</u>	0.2	1.7		0.1	0.7	
<u>Closteriopsis longissima</u>			<0.1	<0.1		
<u>Closterium</u> sp			<0.1	0.2		
<u>Cosmarium</u> sp	0.1	0.4	0.2	4.8	0.2	3.1
<u>Crucigenia</u> sp			<0.1	<0.1	<0.1	<0.1
<u>Elakatothrix gelatinosa</u>	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
<u>Franceia</u> sp			<0.1	<0.1	<0.1	0.1
<u>Colankinia radiata</u>					<0.1	<0.1
<u>Lagerheimia</u> sp			<0.1	<0.1	<0.1	<0.1
<u>Lagerheimia quadriseta</u>					<0.1	<0.1
<u>Oocystis</u> sp			<0.1	0.7	<0.1	0.5
<u>Pediastrum</u> sp	<0.1	0.2	<0.1	0.3		
<u>Pediastrum boryanum</u>					<0.1	0.1
<u>Pediastrum duplex</u>			0.1	1.8	<0.1	0.3
<u>Pediastrum simplex</u>					<0.1	0.4
<u>Pediastrum tetras</u>			<0.1	0.1		
<u>Scenedesmus</u> sp					<0.1	<0.1
<u>Scenedesmus bijuga</u>	0.5	3.4	<0.1	0.6	0.2	2.8
<u>Scenedesmus dimorphus</u>			<0.1	0.6		
<u>Scenedesmus quadricauda</u>	<0.1	0.1	<0.1	1.0	0.1	1.1
<u>Staurastrum</u> sp			0.1	1.2	0.2	3.2
<u>Tetradron</u> sp			<0.1	0.1		
<u>Tetradron minus</u>					<0.1	0.3
Pyrophyta - Total		331.4		2356.0		1018.8
<u>Ceratium hirundinella</u>			0.2	3.5		
<u>Cryptomonas</u> sp	30.4	231.1	93.3	2218.7	64.5	949.4
<u>Peridinium</u> sp	8.3	63.4	0.6	14.9	<0.1	0.6
<u>Rhodomonas minuta</u>	4.9	36.9	5.0	118.9	4.7	68.9
Chrysophyta - Total		4.3		<0.1		0.1
<u>Dinobryon</u> sp					<0.1	0.1
<u>Dinobryon sociale</u>	0.6	4.3	<0.1	<0.1		
Bacillariophyta - Total		415.7		9.4		438.0
<u>Asterionella gracillima</u>	3.9	29.9	<0.1	0.4	7.7	113.4
<u>Cyclotella</u> sp	0.2	1.2				
<u>Cymbella</u> sp	0.1	0.4	0.1	1.1	0.5	7.1
<u>Diatoma</u> sp	5.7	43.0	0.0	<0.1	0.1	0.1
<u>Diatoma elongatum</u>	0.2	1.2			1.3	19.4
<u>Fragilaria</u> sp	<0.1	0.3	<0.1	0.1	1.2	17.3
<u>Fragilaria crotonensis</u>	0.6	4.6	0.1	3.2	1.5	21.9
<u>Gyrodinium</u> sp			<0.1	0.2	<0.1	0.2
<u>Gyrodinium kuetzingii</u>			<0.1	0.2		
<u>Mastogloia</u> sp	0.5	3.5				
<u>Melosira granulata</u>	22.6	172.1	<0.1	0.6	0.2	2.5
<u>Navicula</u> sp					0.0	0.1
<u>Pennales</u>	6.4	48.4	<0.1	0.1	0.3	4.9
<u>Rhoicosphenia curvata</u>	0.1	0.4	<0.1	0.3	0.2	3.4
<u>Rhizosolenia</u> sp					<0.1	0.2
<u>Stephanodiscus</u> sp	<0.1	0.1				
<u>Stephanodiscus binderanus</u>	5.2	39.4			0.3	3.7
<u>Synedra</u> sp	0.9	7.1	<0.1	0.1	<0.1	0.4
<u>Tabellaria</u> sp	0.1	1.1				
<u>Tabellaria fenestrata</u>	8.3	63.0	0.1	3.1	16.6	243.6
MEAN TOTAL BIOMASS		760.1		2378.8		1471.2

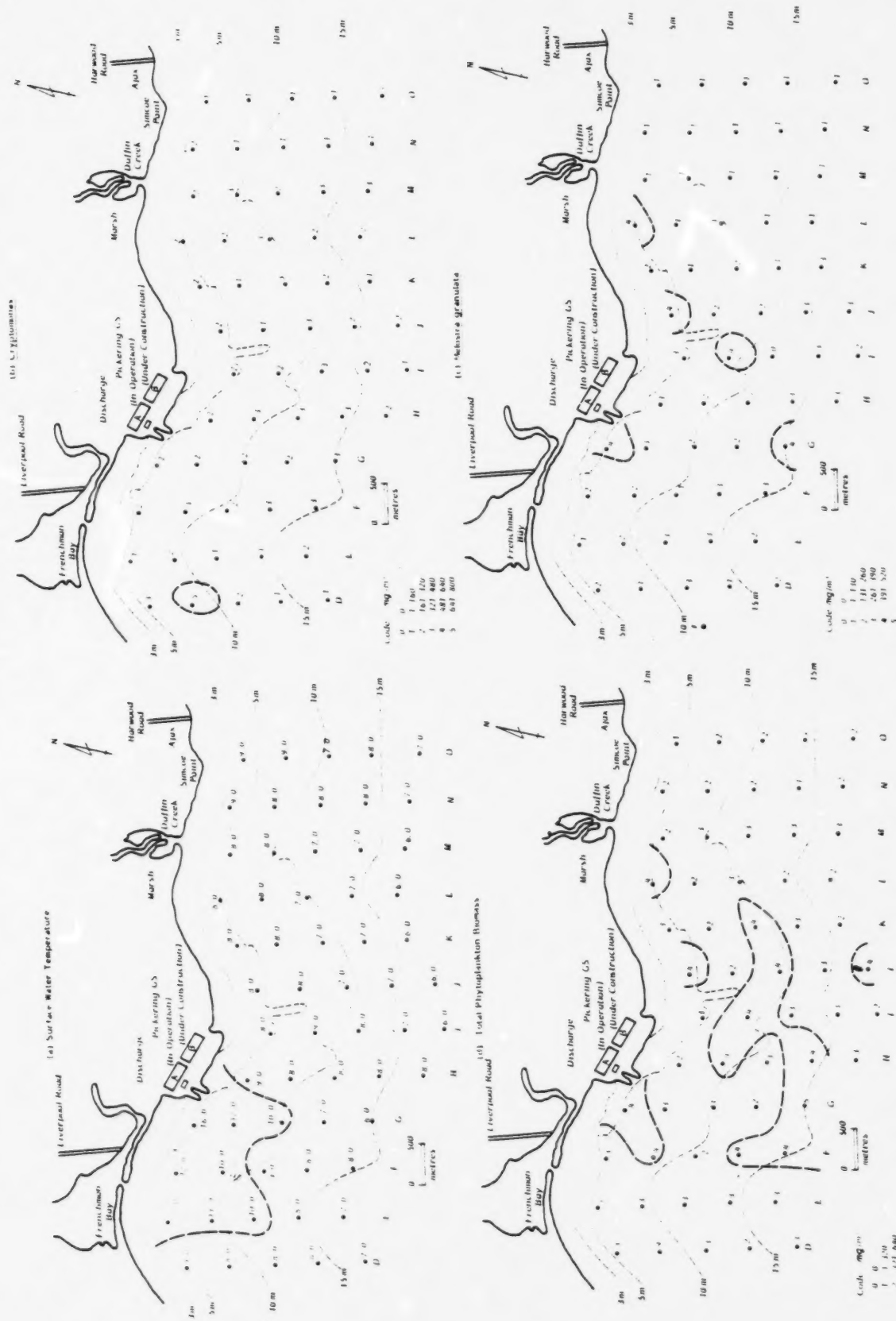


FIGURE 3.4-1

SURFACE WATER TEMPERATURE (a) , AND SURFACE DENSITY DISTRIBUTIONS OF CRYPTOMONAS (b), MELOSIRA GRANULATA (c), AND TOTAL PHYTOPLANKTON (d) IN THE PICKERING G.S. 'B' STUDY AREA, LAKE ONTARIO, ON MAY 21, 1981

On the basis of phytoplankton species composition the samples were grouped into three main groups. The mean relative abundance of the nine main taxa in the samples included in each group is presented in Table 3.4-2.

Group 1 contains samples in which *Cryptomonas* (28% to 44%) was dominant. This group was divided into subgroups on the basis of the subdominant taxa. *M. granulata* and *T. fenestrata* (19% and 17%, respectively) were important in subgroup 1a, *Peridinium* (10%) was subdominant in 1b, and *M. granulata* together with *Peridinium* (30% and 16%, respectively) were important in 1c, while *T. fenestrata* was absent from this subgroup. Samples in Group 2 were codominated by *Cryptomonas* and *M. granulata* (29% and 37%, respectively). Samples in Group 3 differed most from the remaining samples. Strong dominance by a single taxa was missing in these samples and the main taxa present were the diatoms, *T. fenestrata* (17%), unidentified pennales (17%), and *Diatoma* (11%). Group 3 was found at all but one spar on the two most eastern transects (N and O) (Table 3.4-3). In the remainder of the study area the phytoplankton was characterized by the importance of *Cryptomonas* as indicated by its mean relative abundances in Groups 1 and 2. On this day the predominant current direction was to the east. Thus the occurrence of group 3 along the two transects (N and O) east of Duffin Creek may have been an influence of the Duffin Creek effluent.

The density of *Cryptomonas* in the study area on this day ranged between 60 and 768 mg/m³. Highest density was found at the 1.0 km spar on the western most transect, D (Figure 3.4-1b). Lower densities of this taxa were found in the eastern end of the study area along transects N and O, where Group 3 prevailed. *M. granulata* occurred in densities of 8 to 497 mg/m³. With the exception of the 0.5 km location on Transect L, the density of this taxa was lower between Transects L and O than in the remainder of the study area where it was heterogeneously distributed (Figure 3.4-1c). In the thermal plume it was found in highest density at the 0.5 km location on Transect G, the spar closest to the Pickering GS 'A' discharge. In the remainder of the study area it was found in higher densities offshore at the 2.5 km location on Transect G as well as at locations closer to shore on Transects I, J and L. Total phytoplankton biomass ranged from 108 to 1600 mg/m³ with lower biomass generally found along Transects N and O east of Duffin Creek (Figure 3.4-1d). The difference in phytoplankton density as well as the species composition in the area east of Duffin Creek from the remainder of the study area again indicates an effect of the Duffin Creek effluent on the distribution of the phytoplankton.

Within the thermal plume total biomass was highest at the 1.0 and 0.5 km locations on Transects F and G, respectively, in the

TABLE 3.4-2

MEAN RELATIVE ABUNDANCE OF MAIN PHYTOPLANKTON TAXA
IN SAMPLES INCLUDED IN GROUPS
MAY 21, 1981, LAKE ONTARIO AROUND PICKERING GS 'B'

Taxa	%				
	1			2	3
	1a	1b	1c		
<i>Cryptomonas</i>	27.6	44.1	31.2	28.6	6.5
<i>Melosira granulata</i>	19.1	4.0	29.6	32.7	4.2
<i>Peridinium</i> sp	2.4	9.7	16.4	6.7	9.1
<i>Tabellaria fenestrata</i>	17.3	6.8	0.0	5.4	17.4
Unidentified Pennales	6.2	6.5	4.4	5.2	16.9
<i>Diatoma</i> sp	6.4	6.7	3.4	5.4	11.3
<i>Stephanodiscus binderanus</i>	7.3	5.2	5.2	4.7	8.5
<i>Rhodomonas minuta</i>	3.5	6.1	4.0	4.3	10.3
<i>Asterionella gracillima</i>	5.9	4.3	1.8	3.4	8.0

TABLE 3.4-3
DISTRIBUTION OF PHYTOPLANKTON GROUPS
MAY 21, 1981, LAKE ONTARIO AROUND PICKERING GS 'B'

Spar Distance from Shore (km)	Transect											
	D	E	F	G	H	I	J	K	L	M	N	O
0.5	1a	2	2	2	1b	1c	2	1a	2	1b	1b	3
1.0	1b	1a	2	2	1c	2	2	2	1b	1b	3	3
1.5	1c	2	1b	1a	2	1b	2	1c	1b	1a	3	3
2.0	3	2	2	2	2	2	2	2	1b	1b	3	3
2.5	1a	2	2	2	1c	1c	2	2	1b	1b	3	3

path of the Pickering GS 'A' discharge current. In the remainder of the study area higher densities were found from the offshore spars on Transects F and G to an area closer to shore between Transects H and K as well as nearshore on Transect J and L. The density distributions of *Cryptomonas*, *M. granulata*, and total phytoplankton biomass was not related to the development of the thermal plume since similar densities were found within and outside of the plume.

August 6

The surface water temperatures recorded on this day ranged from 18°C to 23.5°C with temperatures greater than 20.5°C only found to the west and southwest of the Pickering GS 'A' discharge (Figure 3.4-2a).

On this date *Cryptomonas* dominated at all sampling locations. Its relative abundance at the various spars did not differ much. It made up at least 90% of the algal biomass in each sample. The relative abundance of *R. minuta* did not vary much between spars making up between 2% and 8% of the total biomass.

The density of *Cryptomonas* was very high on this day ranging between 1112 and 3590 mg/m³. Although its spatial distribution was quite heterogeneous an area of higher densities was observed nearshore between Transects K and N and along Transect L (Figure 3.4-2b). Total phytoplankton biomass ranged from 1233 to 4568 mg/m³ with highest density found at the 2.0 km spar on Transect L (Figure 3.4-2c). Densities greater than 3000 mg/m³ were only found in the area between Transects F and L with a patch of lower densities (1000 to 2000 mg/m³) found nearshore between Transects H and J. As on May 21 the distribution of *Cryptomonas* and total phytoplankton biomass was not related to the development of the thermal plume since similar densities were observed within the plume and at spars in the remainder of the study area.

November 25

The surface water temperatures recorded on this day ranged from 4.5°C to 7°C with temperatures equal or greater than 6°C only found along a band in a southwesterly direction from the Pickering GS 'A' discharge (Figure 3.4-3a).

Cryptomonas was the main taxa present at all the sampling locations contributing to between 48% and 82% of the total biomass. *T. fenestrata* was the subdominant taxa at most spars. It was absent from the 2.5 km location on Transect J and represented between 4% and 32% of the biomass at the remaining locations.

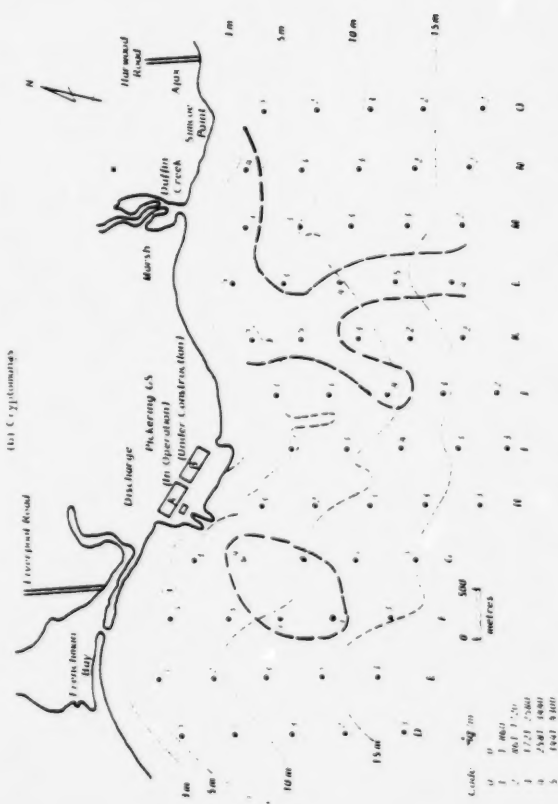
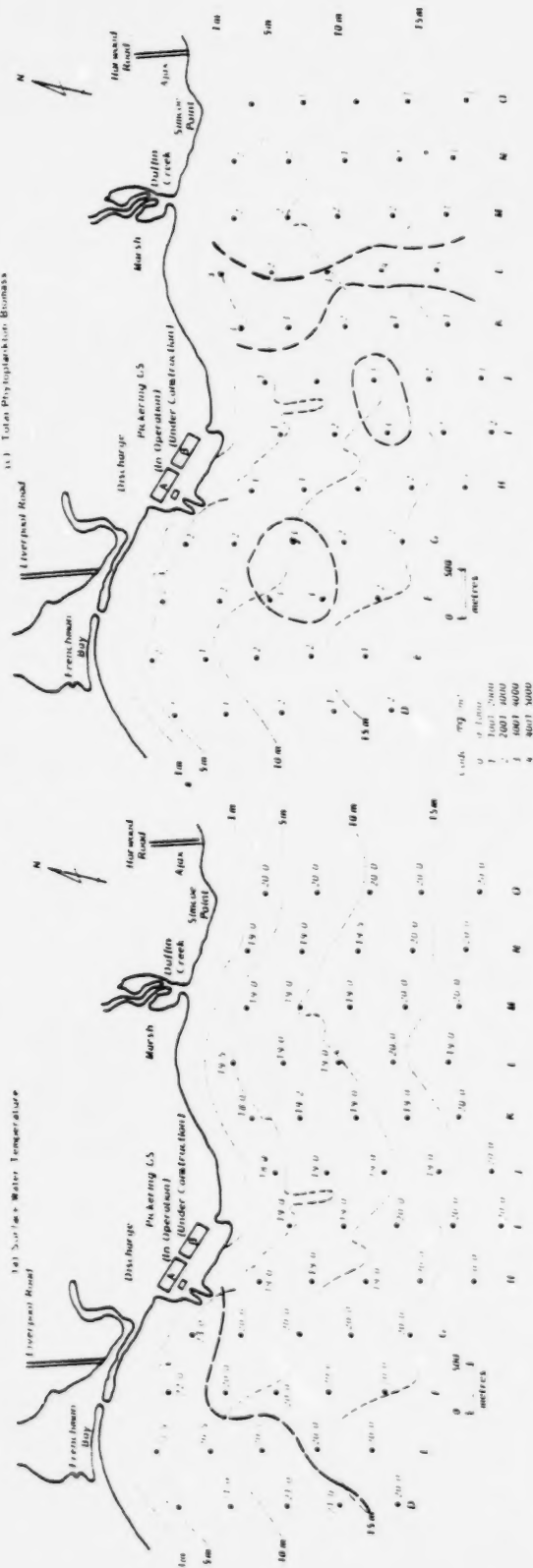


FIGURE 3.4-2

RD SURFACE WATER TEMPERATURE (a), AND DENSITY DISTRIBUTION OF CRYPTOMONAS (b), AND TOTAL PHYTOPLANKTON BIOMASS (c), IN THE PICKERING G.S. 'B' STUDY AREA, LAKE ONTARIO, ON AUGUST 6, 1981

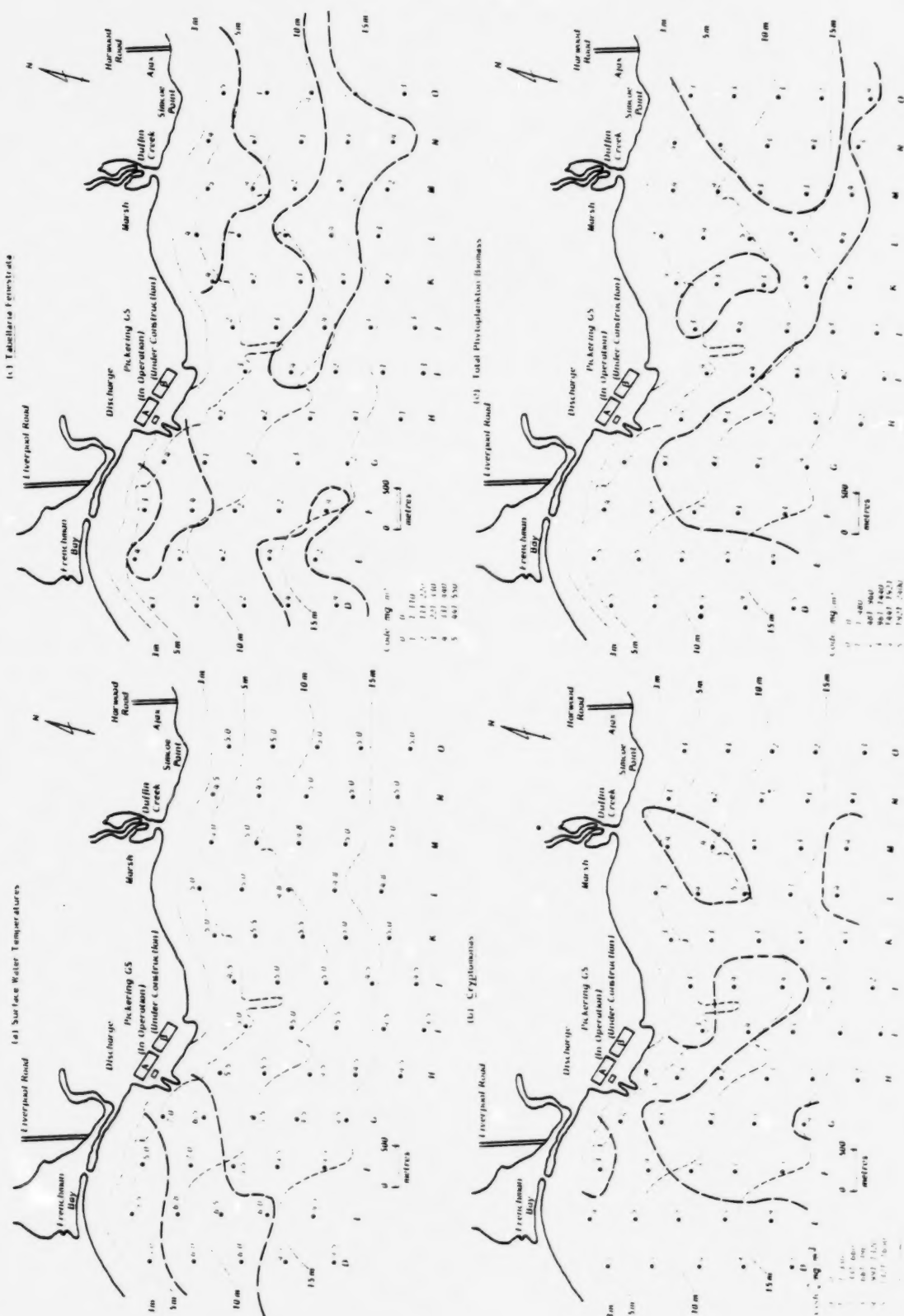


FIGURE 3.4-3

SURFACE WATER TEMPERATURE (a) AND DENSITY DISTRIBUTION OF *CRYPTOMANAS* (b), *TABELLARIA FENESTRATA* (c) AND TOTAL PHYTOPLANKTON BIOMASS (d) IN THE PICKERING G.S. 'B' STUDY AREA, LAKE ONTARIO, NOVEMBER 25, 1981

The density of *Cryptomonas* ranged from 345 to 1570 mg/m³. Lower densities were found in the east of the study area along Transects N and O while higher densities were found in the west of the study area (Figure 3.4-3b). Relatively high densities were also found at the 1.0 and 0.5 km spars on Transects F and G, respectively, where surface temperatures were highest (7°C). *T. fenestrata* was found in densities between 20 and 510 mg/m³. An area of higher densities of this species was found nearshore between Transects K and O and between the 1.0 and 1.5 km locations from Transects R to S (Figure 3.4-3c). Slightly higher densities were also found in the area of the discharge at 0.5 km locations on Transect E and G and the 1.0 km location on Transect F. Higher temperatures were found at the latter two locations but not at the first location. Total biomass ranged between 575 and 2395 mg/m³ with higher densities found to the west of the study area along Transects D and E and nearshore along Transects F and G (Figure 3.4-3d). Thus the area of high algal biomass extends beyond the thermal plume. Total biomass was also higher in the area around Transect L.

With sufficient nutrients available, faster population growth rates of phytoplankton at the elevated temperatures of the thermal plume recorded on the three sampling dates could result in higher algal biomass. However, with the strong currents encountered in the study area (mean current speed at the 8 m depth in the area of the Pickering GS 'B' discharge location was 8.5 cm/s on May 21, 5.9 cm/s on August 6 and 8.4 cm/s on November 25), it is most probable that the phytoplankton do not remain in the plume for extended periods but are rapidly transported out of the immediate discharge area and therefore their density distribution could not be related to the development of the thermal plume. However, frequently observed higher densities around the stations suggest that the phenomenon may be real.

3.5 Zooplankton

Subsurface (0.5 m) zooplankton samples were collected on May 21, August 6, and October 5, 1981. The species composition and mean densities of the rotifers and crustacean zooplankton estimated for these days are presented in Tables 3.5-1 and 3.5-2. Complete data are presented in Appendix VII.

The rotifers outnumbered the crustacean zooplankton on all three sampling dates. On May 21 *Asplanchna* was the main rotifer present (64%) followed by *Gastropus* (9%). The total rotifer density found on this day was 13 155/m³. The crustacean zooplankton consisted mainly of cyclopoid copepods. The cyclopoid copepod nauplii made up the largest portion of the crustacean numbers (72%) followed by the calanoid nauplii

TABLE 3.5-1

SPECIES COMPOSITION AND MEAN DENSITIES OF ROTIFERS COLLECTED
IN LAKE ONTARIO AND PICKERING GS 'B' - 1981

TAXA	May 21		August 6		October 5	
	%	Mean No/m ³	%	Mean No/m ³	%	Mean No/m ³
<i>Trichotria tetractis</i>			<0.1	0.9		
<i>Brachionus angularis</i>	5.7	743.5	0.4	235.8	0.1	0.6
<i>Brachionus calyciflorus</i>	0.3	451.6	1.5	874.0		
<i>Brachionus urceolaris</i>	0.8	105.5	0.1	67.6		
<i>Brachionus</i> spp	0	0.6			0.1	0.3
<i>Epiphanes senta</i>					0.7	3.4
<i>Keratella cochlearis</i>	2.7	352.1	13.0	7 593.2	26.7	122.1
<i>Keratella quadrata</i>	2.3	305.7	1.9	1 106.5	2.5	11.6
<i>Keratella hiemalis</i>	<0.1	1.9	<0.1	2.6		
<i>Keratella earlinae</i>	1.0	125.0	10.8	6 288.8		
<i>Notholca squamula</i>	0.6	81.8	<0.1	5.3	0.5	2.2
<i>Notholca laurentiae</i>	0.9	114.3	<0.1	13.9		
<i>Notholca acuminata</i>	0.4	47.3	<0.1	5.7	0.2	1.0
<i>Notholca foliacea</i>	0.4	45.8	<0.1	2.9		
<i>Kellicottia longispina</i>	2.1	272.0	10.5	6 137.3	5.3	24.2
<i>Trichocerca cylindrica</i>	<0.1	3.1	<0.1	3.7	0.1	0.6
<i>Trichocerca longiseta</i>	<0.1	1.6	<0.1	6.1	1.1	5.0
<i>Trichocerca multigrinis</i>			1.7	975.4	5.2	23.6
<i>Trichocerca porcellus</i>					0.1	0.6
<i>Trichocerca pusilla</i>			<0.1	1.2	0.1	0.3
<i>Lepadella ovalis</i>			<0.1	4.6		
<i>Lepadella patella</i>			<0.1	3.3		
<i>Lepadella</i> spp			<0.1	2.3		
<i>Lecane luna</i>	<0.1	0.3	<0.1	3.0		
<i>Lecane lunaris</i>			<0.1	11.3	0.1	0.6
<i>Cephalodella gibba</i>	<0.1	0.8	<0.1	7.0		
<i>Ascomorpha</i> spp	0.3	40.9	0.4	201.2		
<i>Trochosphaera</i>	<0.1	0.9				
<i>Castropus</i> spp	8.6	1 135.4	0.6	318.9	4.9	22.4
<i>Asplanchna</i> spp	64.2	8 443.9	1.4	807.5	7.8	35.4
<i>Polyarthra</i> spp	6.3	834.2	55.9	32 543.9	42.8	195.2
<i>Synchaeta</i> spp	3.2	414.8	0.1	33.3	0.3	1.3
<i>Ploesoma truncatum</i>			0.1	62.0		
<i>Ploesoma</i> spp	<0.1	4.4			0.1	0.3
<i>Filinia longiseta</i>	0.2	31.1	0.2	126.8	0.2	1.0
<i>Filinia terminalis</i>	<0.1	2.3				
<i>Hexarthra mira</i>	<0.1	0.3	0.5	295.2		
<i>Conochilus unicornis</i>	<0.1	3.7	0.9	513.4	0.3	1.3
<i>Conochilus</i> spp			<0.1	1.2		
Unidentified Rotifer	<0.1	3.7	<0.1	17.2	0.8	3.8
TOTAL		13 154.6		58 272.9		456.7

TABLE 3.5-2

SPECIES COMPOSITION AND MEAN DENSITIES OF CRUSTACEAN
ZOOPLANKTON COLLECTED IN LAKE ONTARIO AT PICKERING GS 'B' - 1981

	May 21		August 6		October 5	
	%	Mean	%	Mean	%	Mean
<i>Diaphanosoma leuchtenbergianum</i>					0.1	0.3
<i>Daphnia</i> spp			<0.1	1.6	0.4	1.3
<i>Daphnia longiremis</i>	<0.1	0.3				
<i>Daphnia retrocurva</i>			0.1	41.9	0.1	0.3
<i>Daphnia galeata mendotae</i>			0.1	44.9	0.4	1.3
<i>Daphnia parvula</i>			<0.1	0.32		
<i>Ceriodaphnia</i> spp			<0.1	5.6		
<i>Ceriodaphnia lacustris</i>			0.2	71.4		
<i>Bosmina longirostris</i>	0.3	7.2	27.3	10 888.2	46.0	152.8
<i>Eubosmina coregoni</i>			0.7	279.9	1.5	5.1
<i>Alona</i> spp					0.4	1.3
<i>Polyphemus pediculus</i>	<0.1	0.3		.		
<i>Leydigia quadrangularis</i>					0.2	0.63
<i>Limnocalanus macrurus</i>			<0.1	6.5		
<i>Diaptomus oregonensis</i>	2.5	68.7	0.1	22.8	6.3	21.1
<i>Diaptomus minutus</i>	0.5	13.0	0.2	94.5		
<i>Diaptomus sicilis</i>					0.1	0.3
<i>Diaptomus ashlandi</i>	0.1	1.7	<0.1	4.6		
Calanoid nauplii	19.8	544.0	29.0	11 570.3	4.5	14.9
Calanoid copepodites	0.8	22.0	1.5	577.2	2.2	7.2
<i>Tropocyclops prasinus</i>			0.2	65.6		
<i>Diacyclops bicuspidatus thomasi</i>	0.9	24.2	4.5	1 806.6	17.4	57.9
<i>Mesocyclops edax</i>					0.1	0.3
Cyclopoid nauplii	72.4	1 992.5	33.5	13 349.3	6.5	21.5
Cyclopoid copepodites	2.9	78.3	2.7	1 060.3	14.0	46.5
TOTAL		2 752.2		39 891.5		332.7

(20%). The only adult cyclopoid copepod present was *Diacyclops bicuspidatus thomasi* and the cyclopoid nauplii probably belonged largely to this species. The main calanoid copepod present was *Diaptomus oregonensis*. The densities of the Cladocera was extremely low. The main cladoceran present was *Bosmina longirostris* which only made up 0.3% of the total crustacean numbers. The mean total number of crustacean zooplankton estimated for the study area was 2752/m³.

Polyarthra was the main rotifer present on August 6 (56%). Other important rotifers present on this day included *Keratella cochlearis* (13%) *K. earlinae* (11%) and *Kellicottia longispina* (11%). The cyclopoid copepods were again the main crustacean zooplankton present. The cyclopoid and calanoid copepod nauplii made up the largest portions of the crustacean numbers (34% and 29%, respectively). *D. bicuspidatus thomasi* was again the main cyclopoid copepod present, while *Diaptomus minutus* was the main calanoid copepod present. The density of the cladocerans was substantially higher on this day than on May 21 with *B. longirostris*, the main cladoceran present, representing 27% of the crustacean numbers. Highest rotifer and crustacean zooplankton densities (58 273 and 39 892/m³) were found on this day as was the case with the phytoplankton biomass.

On October 5, *Polyarthra* was again the main rotifer present (43%) followed by *K. cochlearis* (27%). *B. longirostris* made up the largest portion of the crustacean numbers (46%) followed by the *Diacyclops bicuspidatus thomasi* adults (17%) and the cyclopoid copepodites (14%). The main calanoid copepod present was *D. oregonensis*, the adults of which represented 6% of the total numbers. Lowest abundances of rotifers and crustacean zooplankton (457 and 333/m³, respectively) were estimated on this day.

Species or species belonging to the genera identified as the main rotifers present on the three dates (*Asplanchna*, *polyarthra*, and *Keratella*) were identified by Nauwerck (1978) as quantitatively important rotifers of Lake Ontario in 1970. More than half of the rotifer taxa identified, and all the taxa representing at least 1% of the total numbers in our samples, were identified as common rotifers of Lake Ontario by Nauwerck (1978). Dominance by *Asplanchna*, a rotifer predator, has not been observed in our previous studies at the Pickering GS site (Ontario Hydro Research Division Report No 80-126-K, 82-266-K, and the Pickering GS 'B' Preoperational Biological Study - Year II, in draft). Patalas (1969) and Watson (1974) both found *D. bicuspidatus thomasi* and *B. longirostris* to be the most abundant copepod and cladoceran in Lake Ontario. Studies conducted as part of the Pickering GS 'A' postoperational study between 1974 and 1976 (Ontario Hydro Research Division Report

No 80-226-K) and the present study in 1979 and 1980 (Ontario Hydro Research Division Report No 82-266-K and Ontario Hydro Research Division Report No 82-460-K) also identified *D. bicuspidatus thomasi* as the main copepod and *B. longirostris* as the main cladoceran in the study area.

May 21

On this day the surface water temperatures in the study area ranged from 6°C to 16 °C with temperatures of 10°C and over only found in the area immediately to the south and west of the Pickering GS 'A' discharge (Figure 3.5-1a).

Asplanchna was the dominant rotifer present at most locations (Table 3.5-3). It was not collected at the 2.5 km location on Transect D, the western most transect, and the 1.0 km location on Transect H, in the vicinity of the intake. At the remaining locations its relative abundance varied substantially and ranged from 4% to 84%. *Gastropus* (27%) was the main taxa found at the 2.5 km location on Transect D, *K. cochlearis* (31%) was dominant at the 1.0 km location on Transect H, while *B. angularis* (21% to 36%) was the main species present at several locations along Transect E and F, around Frenchman Bay. The cyclopoid copepod nauplii made up the largest portions of the crustacean zooplankton numbers at all locations except the 0.5 km location on Transect D where the calanoid copepod nauplii were the main group (54%). The cyclopoid nauplii made up between 36% and 83% of the total crustacean zooplankton numbers at the various spars.

TABLE 3.5-3

LOCATIONS WHERE DOMINANT ROTIFER WAS *ASPLANCHA* (1),
GASTROPUS (2), *KERATELLA COCHLEARIS* (3)
 OR *BRACHIONUS ANGULARIS* (4) ON
MAY 21, 1981, LAKE ONTARIO AROUND PICKERING GS 'B'

Spar Distance from Shore (km)	Transect											
	D	E	F	G	H	I	J	K	L	M	N	O
0.5	1	1	1	1	1	1	1	1	1	1	1	1
1.0	1	4	1	4	3	1	1	1	1	1	1	1
1.5	1	1	1	1	1	1	1	1	1	1	1	1
2.0	1	4	1	4	1	1	1	1	1	1	1	1
2.5	2	4	1	1	1	1	1	1	1	1	1	1

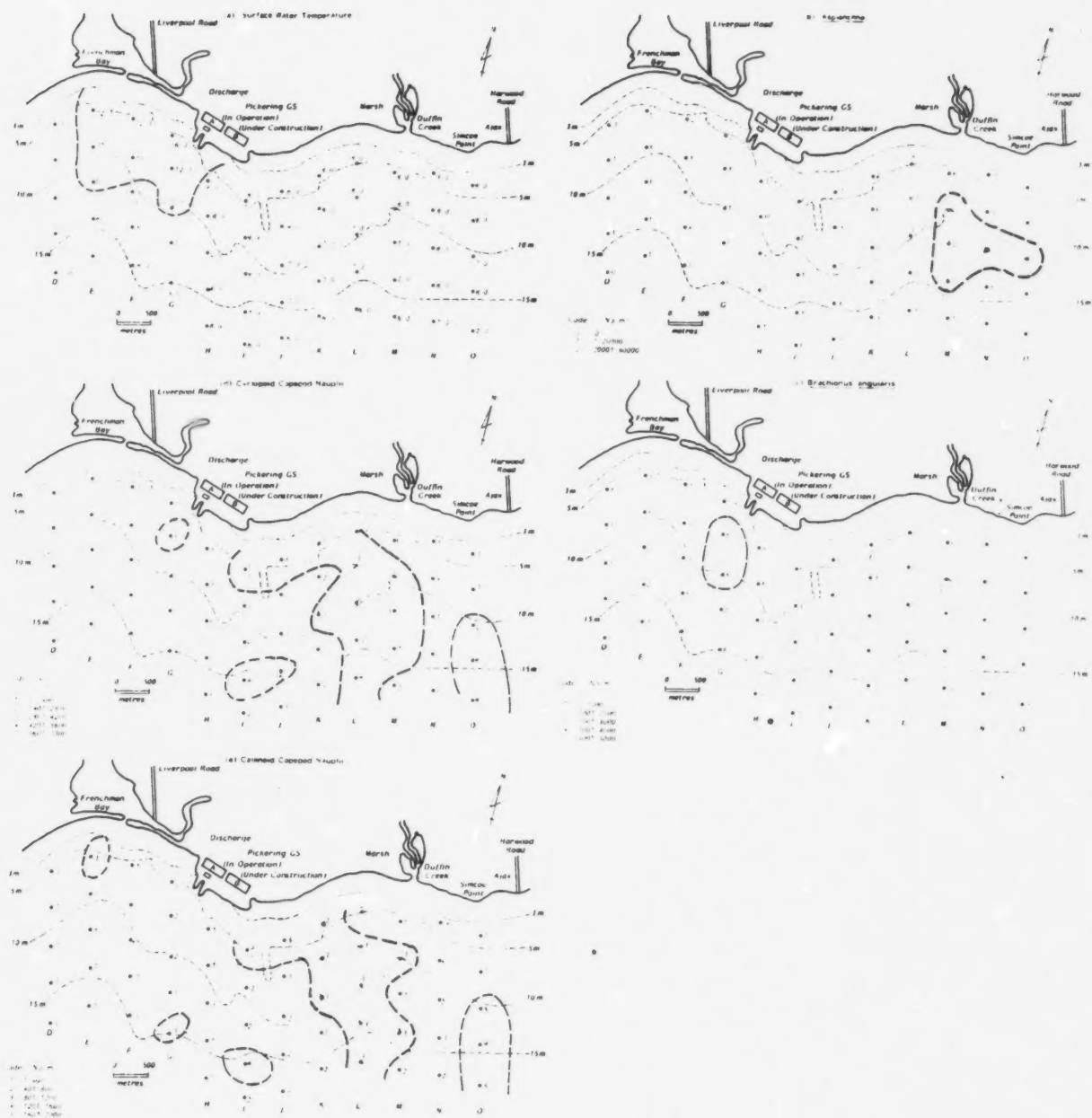


FIGURE 3.5-1
SURFACE WATER TEMPERATURE (a), AND SURFACE DENSITY
DISTRIBUTION OF *ASPLANCHNA* (b), *BRACHIONUS ANGULARIS* (c)
CYCLOPID COPEPOD NAUPLII (d), AND CALANOID COPEPOD NAUPLII (e),
IN THE PICKERING G.S. 'B' STUDY AREA, LAKE ONTARIO,
ON MAY 21, 1981

The density of *Asplanchna* varied substantially (0 to 36 835/m³). Densities greater than 20 000/m³ were only found in the eastern section of the study area between Transects K and O (Figure 3.5-1b). The abundance of *B. angularis* ranged between 19 and 4887/m³ with highest abundances found at the 1.0 and 1.5 km locations on Transect G (Figure 3.5-1c). These two locations were within the thermal plume with temperatures of 12°C and 10°C, respectively. The cyclopoid nauplii were found in numbers between 93 and 6682/m³. It was found in higher densities in the eastern half of the study area with an area of high abundance also found nearshore on Transects I and J (Figure 3.5-1d). Slightly higher numbers of *B. angularis* were also found at these locations. The calanoid nauplii occurred in densities of 19 to 1777/m³ and had a distribution similar to that of the cyclopoid nauplii with higher densities in the eastern portion of the study area. Within this area higher densities were found nearshore at Transects I and J, and between the 1.5 and 2.5 km locations on Transect O.

August 6

The surface temperature at the various spars ranged from 18°C to 23.5°C with temperatures over 20°C limited to the area to the west and southwest of the Pickering GS 'A' discharge (Figure 3.5-2a).

With the exception of the 1.5 km location on Transect N, *Polyarthra* was either dominant at a location or absent (Table 3.5-4). Its relative abundance where it was present ranged from 22% to 71%. *K. cochlearis* was the main species found at the 1.5 km location on Transects J and N (35% and 39%, respectively) and the 0.5 km location on Transect K (34%). *K. earlinae* dominated at the 1.0 and 2.0 km location on Transect H and I (45% and 25%, respectively) and *Asplanchna* was dominant at the 2.5 km spar on Transect R (43%). Of the crustacean zooplankton, the cyclopoid copepod nauplii were more important in the center of the study area while *B. longirostris* was more important in the western and eastern sections of the study area (Table 3.5-5). The relative abundance of the cyclopoid nauplii ranged from 13% to 46% while that of *B. longirostris* ranged from 5% to 74%. The calanoid nauplii only made up the largest portion of the crustacean numbers at the 1.5 km location on Transect G.

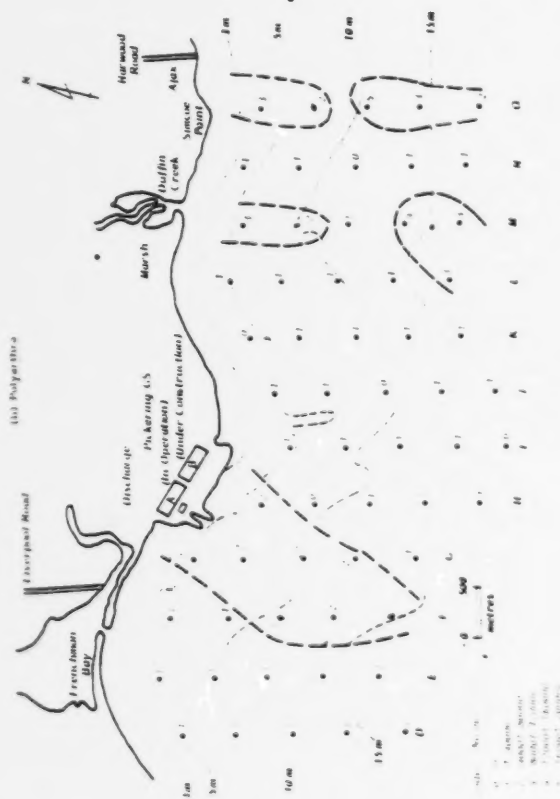
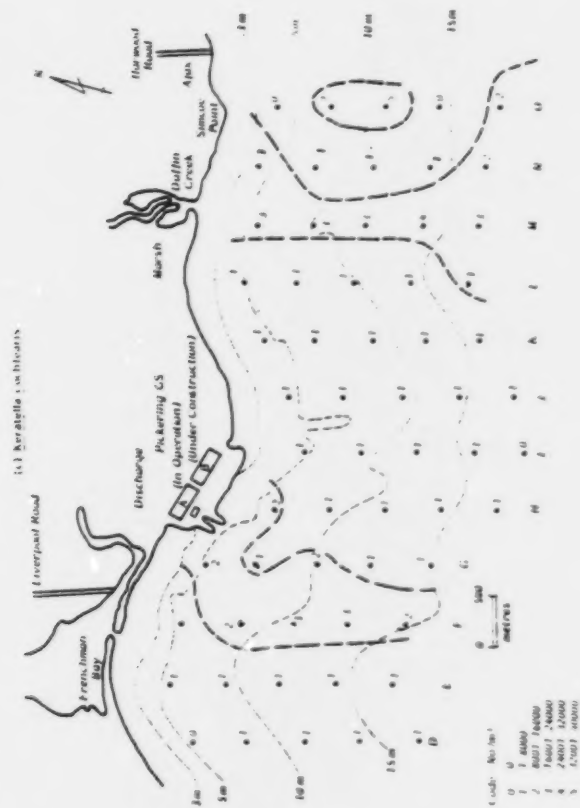


FIGURE 3.5-2

SURFACE WATER TEMPERATURE (a) AND SURFACE DENSITY DISTRIBUTION OF POLYARTHRA (b) AND KERATELLA COCHLEARIS IN THE PICKERING 'B' STUDY AREA, LAKE ONTARIO, ON AUGUST 6, 1981

TABLE 3.5-4

LOCATIONS WHERE ROTIFERS WERE DOMINATED BY *POLYARTHRA* (1),
KERATELLA COCHLEARIS (2), *KELICOTTIA LONGISPINA* (3)
 AND *ASPLANCHNA* (4) IN LAKE ONTARIO
 AROUND PICKERING GS 'B' ON AUGUST 6, 1981

Spar Distance from Shore (km)	Transect											
	D	E	F	G	H	I	J	K	L	M	N	O
0.5	1	1	1	1	1	1	1	2	1	1	1	1
1.0	1	1	1	1	3	1	1	1	1	1	1	1
1.5	1	1	1	1	1	1	2	1	1	1	2	1
2.0	1	1	1	1	1	3	1	1	1	1	1	1
2.5	1	1	1	1	1	4	1	1	1	1	1	1

TABLE 3.5-5

LOCATIONS WHERE MAIN CRUSTACEAN ZOOPLANKTON PRESENT WERE
 CYCLOPOID COPEPOD NAUPLII (1), CALANOID COPEPOD NAUPLII (2),
 AND *BOSMINA LONGIROSTRIS* (3), LAKE ONTARIO
 AROUND PICKERING GS 'B' ON AUGUST 6, 1981

Spar Distance from Shore (km)	Transect											
	D	E	F	G	H	I	J	K	L	M	N	O
0.5	3	1	1	1	1	1	1	1	3	1	1	1
1.0	3	3	1	1	1	1	1	1	3	1	3	3
1.5	3	3	1	2	1	1	1	1	1	3	1	1
2.0	3	3	1	1	1	1	1	1	3	1	1	1
2.5	3	3	1	3	1	1	3	1	3	1	3	3

Polyarthra whose abundance varied between 926 and 185 925/m³ was found in higher abundance in the area south of the Pickering GS 'A' discharge between 1.5 and 2.5 km on Transect F, 0.5 and 2.0 km on Transect G and at 0.5 km on Transect H and in the eastern section of the study area along Transects M and O (Figure 3.5-2b). The distribution of *K. cochlearis* which was found in densities ranging from 871 to 38 944/m³ was quite similar to that of *Polyarthra* with higher densities found to the south of the Pickering GS 'A' discharge and at the spars in the

eastern section of the study area (Figure 3.5-2c). *K. earlinae* whose abundance ranged between 149 and 29 406 m³ occurred in higher densities in the eastern part of the study area (Figure 3.5-3a). The density of *K. longispina* ranged from 593 to 23 878/m³. Higher densities were found along Transect M at Duffin Creek and in the western section of the study area between Transects H and D, especially immediately south of the stations (Figure 3.5-3b).

The cyclopoid nauplii were found in numbers from 426 to 72 744/m³ and was found in higher numbers at spars in the western section of the study area between Transects E and H (Figure 3.5-3c). Largest numbers were found at the 0.5 km location on Transect G, the spar closest to the Pickering GS 'A' discharge. As on the previous date, the distribution of the calanoid nauplii was quite similar to that of the cyclopoid nauplii. Their density ranged from 463 to 69 135/m³. Higher numbers were found between Transects E and G with largest density observed at the 0.5 km location on Transect G (Figure 3.5-4a). Slightly higher densities of the copepod nauplii were also observed at the 0.5 and 1.0 km locations on Transect M at the mouth of Duffin Creek. *B. longirostris* densities ranged between 335 and 73 299/m³. It was found in higher numbers at spars located on Transects D, E, F, and G, with highest numbers found at the 1.0 and 1.5 km locations on Transect E (Figure 3.5-4b). In the remainder of the study area slightly higher abundances of this species were found at the 0.5 and 1.0 km location along Transect M at Duffin Creek. The abundance of the adult *D. biscuspidatus thomasi* which ranged from 56 to 11 939/m³ was higher at spars on Transects E, G and H in the area of the stations and at the 0.5 and 1.0 km spars on Transect M at Duffin Creek (Figure 3.5-4c) with highest numbers found at the latter location.

The higher densities of most of the main zooplankton observed around the stations partially overlapped with the thermal plume and extended further west of the plume. Thus their spatial distribution did not appear to be directly related to surface water temperature. The zooplankton were also found in higher densities nearshore along the Duffin Creek Transect (M) indicating a possible effect of the creek.

October 5

The surface temperatures in the study area ranged from 6.5°C to 13.0°C on this day with temperatures of 8.8°C and up recorded from the 0.5 km spar on Transect I southwestward to the 2.0 km location on Transect D (Figure 3.5-5a).

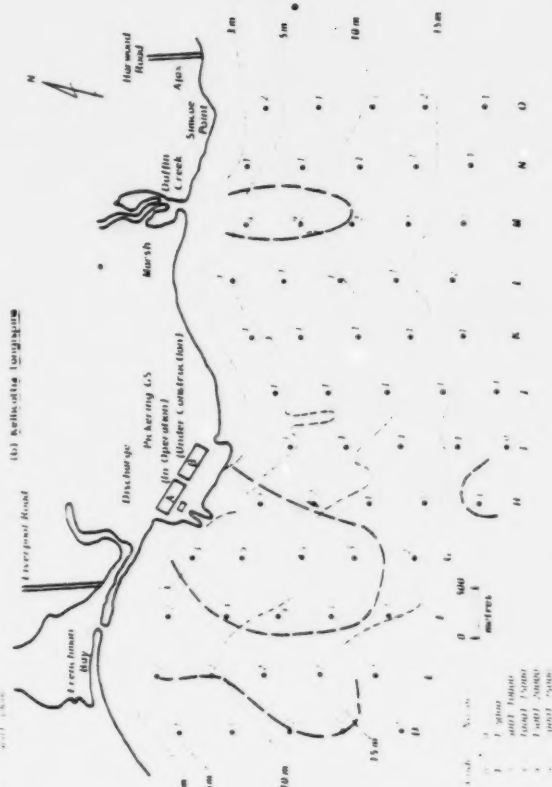
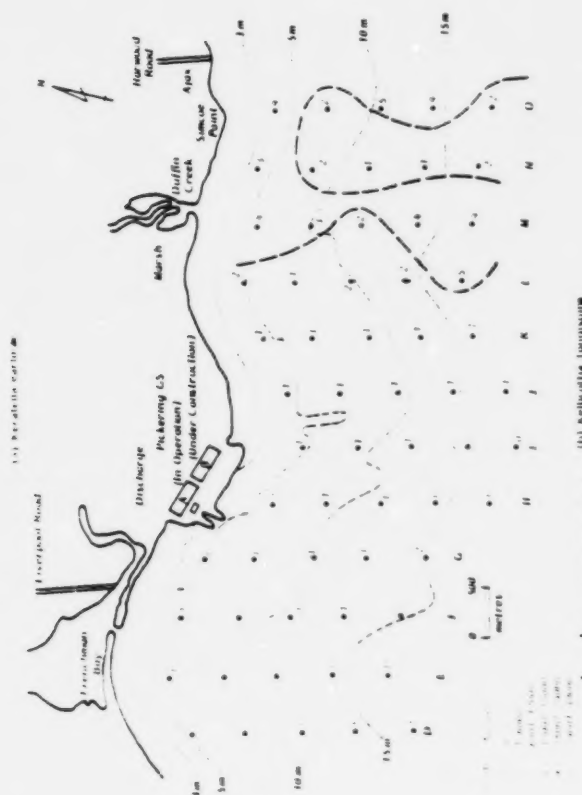
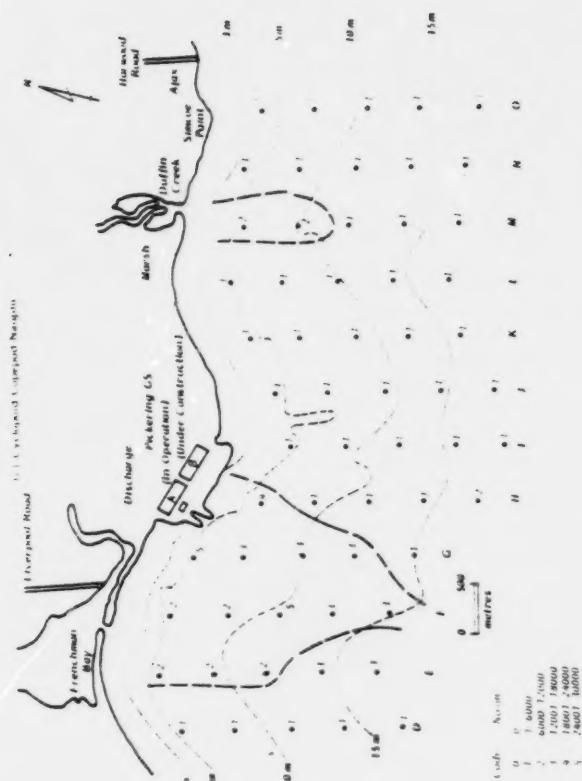


FIGURE 3.5-3

SURFACE DENSITY DISTRIBUTION OF *KERATELLA EARLINA* (a), *KELLICOTTIA LONGISPINA* (b), AND THE CYCLOPOID COPEPOD NAUPLII (c) IN THE PICKERING G.S. 'B' STUDY AREA, LAKE ONTARIO, ON AUGUST 6, 1981

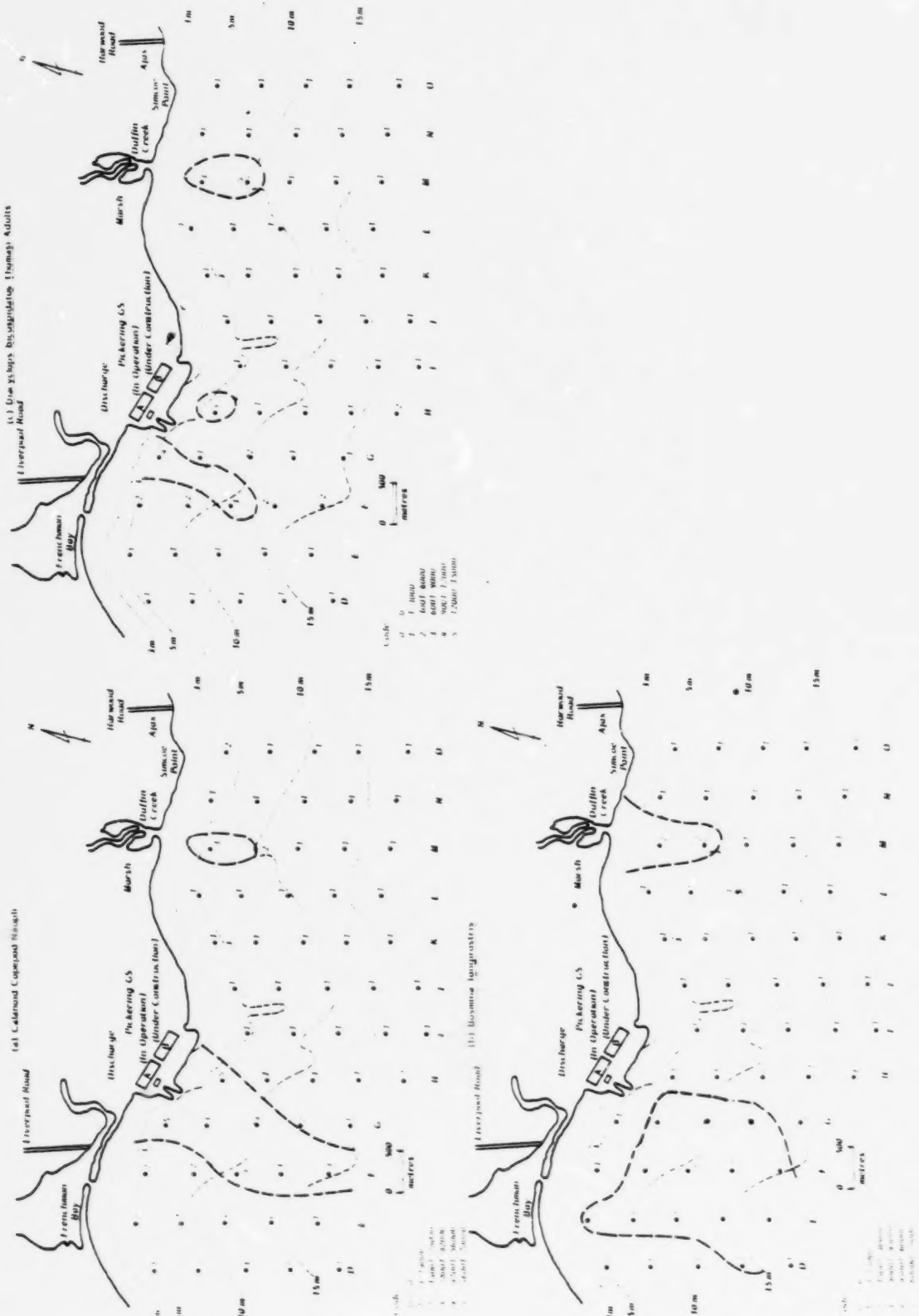


FIGURE 3.5-4
 SURFACE DENSITY DISTRIBUTION OF CALANOID COPEPOD NAUPLII (a) *BOSMINA LONGIROSTRIS* (b),
 AND *DIACYCLOPS BICUSPIDATUS THOMASI* (c), IN THE PICKERING G.S. 'B' STUDY AREA,
 LAKE ONTARIO ON AUGUST 6 1981

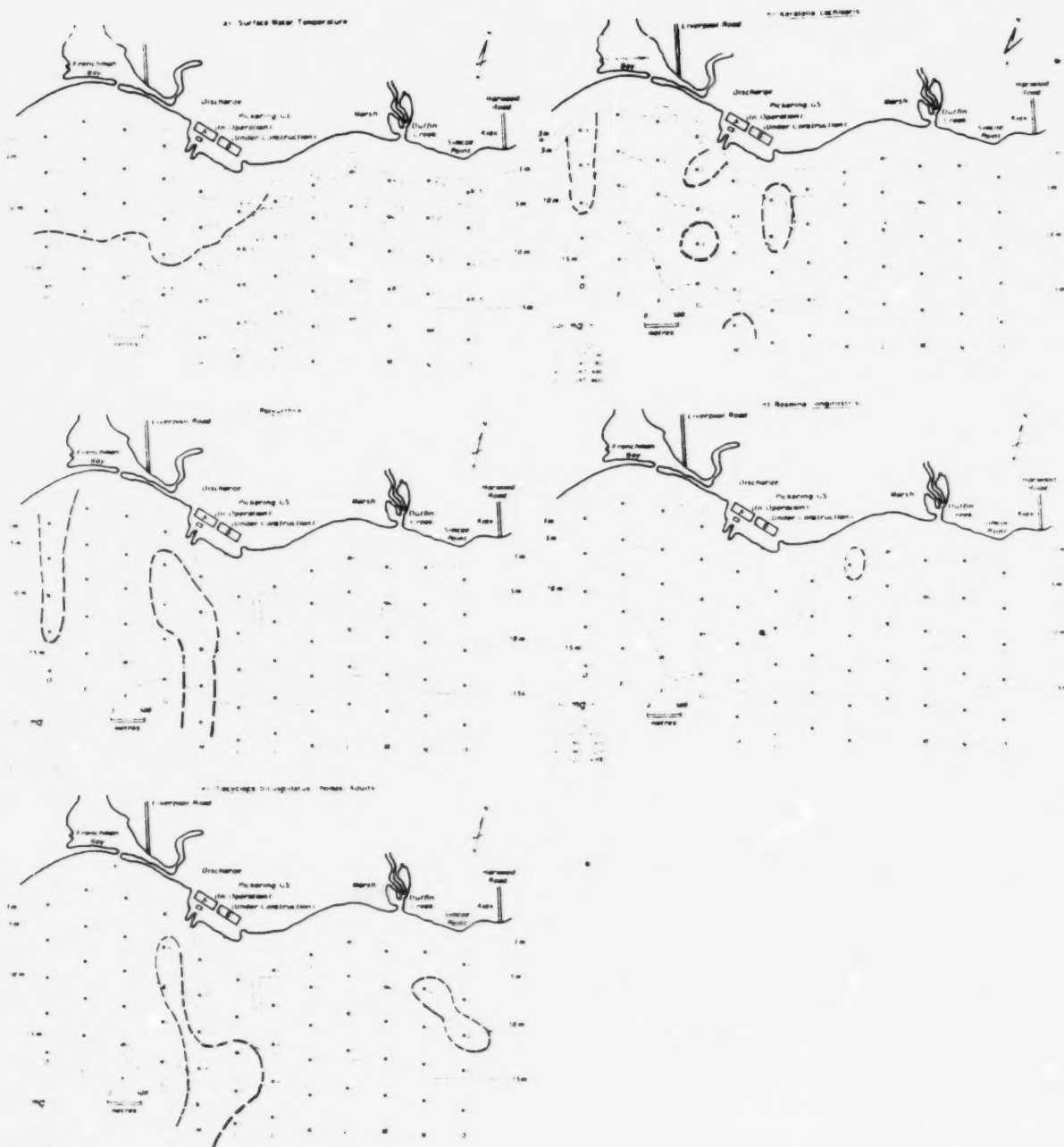


FIGURE 3.5-5
 SURFACE WATER TEMPERATURE (a), AND SURFACE DENSITY DISTRIBUTION
 AT *KERATELLA COCHLEARIS* (b), *POLYARTHRA* (c),
BOSMINA LONGIROSTRIS (d), AND *DIACYCLOPS BICUSPIDATUS THOMASI* ADULTS (e)
 IN THE PICKERING G.S. 'B' STUDY AREA, LAKE ONTARIO,
 ON OCTOBER 5, 1981

Polyarthra or *K. cochlearis* was the main rotifer present at all but two locations (Table 3.5-6); the 1.0 km location along Transect L where definite dominance by a single taxa was lacking and the 2.5 km location on Transect N where *T. multicroinis* was dominant on Transect N (28%). At the locations where *Polyarthra* was found its relative abundance ranged from 5% to 86% while that of *K. cochlearis*, which was present at all locations, ranged from 5% to 72%. *K. cochlearis* was more prominent between 1.5 and 2.5 km on Transects L and M. The cyclopoid copepod (*D. bicuspidatus thomasi* adults, copepodites and nauplii) made up the largest portions of the crustacean numbers at most locations (Table 3.5-7). *B. longirostris* dominated at the remaining spars except for the 1.5 km location on Transect F where *D. oregonensis* and *Diaphanasoma leuchtenbergianum* were the main species. *B. longirostris* was more prominent in the eastern section of the study area along Transect K and inshore on Transects M and N. At the spars where they were present the cyclopoid copepods represented between 11% and 100% of the numbers while *B. longirostris* represented between 4% and 99%.

TABLE 3.5-6

LOCATIONS WHERE ROTIFERS WERE DOMINATED BY *POLYARTHRA* (1),
KERATELLA COCHLEARIS (2), *TRICHOCERCA MULTICRINIS* (3)
 OR WHERE DEFINITE DOMINANCE WAS LACKING (4)
 IN LAKE ONTARIO AROUND PICKERING GS "B" ON OCTOBER 5, 1981

Span Distance from Shore (km)	Transect											
	D	E	F	G	H	I	J	K	L	M	N	O
0.5	1	1	1	2	1	2	2	1	1	1	2	1
1.0	1	2	2	1	1	2	1	1	4	1	2	1
1.5	1	1	2	1	1	1	1	1	2	2	1	1
2.0	1	1	1	2	1	1	2	1	2	2	1	1
2.5	2	1	1	1	1	2	1	1	2	2	3	1

The abundances of the two main rotifers present on this day were low. The density of *Polyarthra* ranged from 19 to 1167/m³ with higher densities found along transects in the western section especially at the 0.5 and 1.0 km locations on Transect D (Figure 3.5-5b). *K. cochlearis* whose density was between 19 and 556/m³ was also found to be more abundant at spars in the western half of the study area with highest abundance at the 0.5 and 1.0 km locations on Transect D (Figure 3.5-5c). The

areas where these two rotifers were found in higher densities overlapped substantially with the development of the thermal plume although the densities did not appear to be directly related to surface temperature since densities equal to those found within the plume were also observed outside of the plume. *B. longirostris*, which was absent from some locations, was found in abundances of 19 to 3982/m³ at the spars where it was present. Substantially higher densities of this species was found at the 0.5 and 1.0 km locations on Transect K than in the remainder of the study area (Figure 3.5-5d). At the locations where they were present, *D. bicuspidatus thomasi* adults were found in numbers from 19 to 204/m³ with slightly higher densities found towards the center and eastern end of the study area (Figure 3.5-5e).

TABLE 3.5-7

LOCATIONS WHERE THE CRUSTACEAN ZOOPLANKTON WERE DOMINATED BY THE CYCLOPOID COPEPODS (1), *BOSMINA LONGIROSTRIS* (2), CO-DOMINATED BY *DIAPTOMUS OREGONENSIS* AND *DIAPHANASOMA LEUCHTENBERGIANUM*, LAKE ONTARIO AT PICKERING GS 'B', OCTOBER 5, 1981

Spar Distance from Shore (km)	Transect											
	D	E	F	G	H	I	J	K	L	M	N	O
0.5	1	1	2	1	1	2	1	2	2	2	1	
1.0	1	1	1	1	1	1	1	2	2	2	1	
1.5	1	1	3	1	1	1	1	2	1	1	1	
2.0	1	1	1	1	1	1	1	2	1	1	1	
2.5	1	1	1	1	1	1	2	2	1	1	1	

On two of the the three sampling days most of the main zooplankton taxa present occurred in higher abundances in the areas of the generating station and Duffin Creek. On May 21 the predominant current direction was to the east (E, ESE) and the higher densities were found to the southeast of the two discharge sources. On August 6, the current changed direction several times during the day. The higher densities on this day were found to the southwest of the stations and Duffin Creek. On October 5 the densities of the zooplankton were very low and higher densities of most of the main taxa were found at locations in the western half of the study area. The predominant

current direction on this day was to the east (E, ESE) in the morning and to the West (SW, WSW) during the later part of the day.

In most cases the density distribution of the main rotifer and crustacean zooplankton did not appear to be related to the surface water temperatures with similar abundances found at locations within the plume and outside of the plume. Developmental rates of zooplankton are faster at higher temperatures up to a maximum threshold temperature above which the rates decrease. If the zooplankton remain within the thermal plume long enough to reproduce, the faster developmental rates should result in higher densities provided sufficient food is available. With the strong surface currents encountered in the study area, zooplankton are rapidly transported out of the immediate discharge area and therefore their density distribution could not be related to the development of the thermal plume at the time of sampling. The mean daily current recorded in the area of the Pickering GS 'B' discharge location at the 8 m depth was 8.5 cm/s on May 21, 5.9 cm/s on August 6 and 9.5 cm/s on October 6. However, frequently encountered higher densities around the stations in the three years of the Pickering GS 'B' preoperational study seem to indicate some influence of the stations while frequent higher densities found around Duffin Creek appear to indicate some influence of the Creek's effluent on the zooplankton.

Evans (1981), in explaining the higher zooplankton densities she found in the warmer waters of the Donald C. Cook nuclear power plant thermal plume, found that water temperature was not a reliable indicator of alterations in zooplankton populations and suggested that the changes were primarily due to upward vertical displacement of deep-living zooplankton. Data obtained on the vertical distribution of the zooplankton on June 17, 1976 around Pickering GS (12 m depth) indicated higher abundances of *D. bicuspidatus thomasi*, cyclopoid nauplii and *B. longirostris* in deeper waters during the daytime (Ontario Hydro Research Division Report No C78-78-K). *Polyarthra* and *Synchaeta* were also more abundant below the 1 m subsurface statum (Ontario Hydro Research Division Report No C78-78-K).

3.6 Zoobenthos

The original data matrix of invertebrate identifications for these collections is attached (Appendix VII).

Oligochaete taxa numerically dominated the benthic faunal community, representing 83% of total zoobenthos collected (Table 3.6-1). Although Oligochaeta were more abundant than Diptera (14%), nearly twice as many dipteran taxa (47) were

TABLE 3.6-1

Per Cent Composition and Mean Density (No/m²) of Macroinvertebrate
Taxonomic Groups at Pickering GS 'B' - 1981

Taxon	Date							
	July		August		October		Year	
	Density No/m ²	%	Density No/m ²	%	Density No/m ²	%	$\bar{X}$ Density No/m ²	%
Oligochaeta	4952	79.5	5163	87.1	421	75.8	3481	82.9
Crustacea								
Amphipoda	63	0.9	142	2.4	41	7.3	81	1.9
Isopoda	0	0.0	12	0.2	1	0.2	4	0.1
Gastropoda	4	0.1	26	0.4	10	1.8	13	0.3
Acarina	11	0.1	33	0.6	17	3.0	20	0.5
Insecta								
Diptera	1337	19.2	544	9.2	61	10.9	623	14.1
Trichoptera	15	0.2	5	0.1	4	0.7	8	0.2
Ephemeroptera	0	0.0	5	0.1	0	0.0	2	<0.1
Hirudinea	1	<0.1	2	<0.1	1	0.2	1	<0.1
Total Benthos Density	6383	100	5926	100	556	100	4183	100

collected as were oligochaetes (24). Amphipods were the third most abundant group, accounting for 2% of the benthic invertebrate numbers, and 5 taxa. These three groups totaled 98.9% of the total benthos collected in 1981. Isopoda, Gastropoda, Acarina, Hirudinea, and two other insect orders (Trichoptera, Ephemeroptera) made up the remaining 1.1% (Table 3.6-1).

Common invertebrates (constituting at least 1% of the total monthly sample) are listed in Table 3.6-2. The oligochaetes were represented mainly by two families, the Naididae and Tubificidae. The naids (*Vejdovskyella*, *Nais*, *Amphichaeta*, *Stylaria*) were more common than the tubificids (*Tubificidae*, *Peloscoides*). The Diptera were entirely represented by the family Chironomidae, principally the Orthocladinae and Chironominae. The genus *Gammarus* was the only common amphipod.

Total benthic density (no/m²) was at a maximum in July at 6383/m² (Table 3.6-1). Density fell slightly in August to 5926/m² and was much lower in October at 556 individuals/m².

Zoobenthic density estimations for all samples collected are shown in a spatial-temporal matrix (Table 3.6-3). Density was generally lowest at the 1 m depth, increasing with depth to a maximum at either the 7 m or 12 m depths. No east-west density clines were evident, but benthic densities at the 3 m and 7 m depth along the Pickering GS 'A' discharge transect were generally reduced.

Taxonomic Richness

The number of taxa (taxonomic richness) that are found in a sample can give an indication of the suitability of an area for resident fauna (Thienemann 1954). Table 3.6-4 lists taxonomic richness for all samples. Richness decreases with time; an average 13 taxa per plot were collected in July, 11 in August and 5 in October.

This pattern is quite different than that found in the 1979 survey (Ontario Hydro Research Division Report No. 82-266-K), which found greatest densities and taxonomic richness in August, with lower, and approximately equal values for the earlier and later sampling periods. The difference in temporal trends between the two years may be due to sampling variability, rather than environmental factors. Richness, like density, reaches maximum values at the 7 or 12 m spars; richness is often related to sample size (Krebs 1972). Transects G, in the vicinity of the Pickering GS 'A' discharge, I, in the vicinity of the Pickering GS 'B' discharge location, and O, at Simcoe Point supported the greatest number of taxa throughout the season (Table 3.6-4).

TABLE 3.6-2

Per Cent Composition and Mean Densities (No/m²)
of Dominant Zoobenthic Taxa (Representing >1% of
Total Taxa) at Pickering GS 'B' - 1982

Taxon	July		August		October		Year	
	No/m ²	%	No/m ²	%	No/m ²	%	$\bar{x}$ No/m ²	%
<i>Vejdovskyella comata</i>	2744	41	2262	38	19	3	1726	40
Tubificidae	986	15	2324	39	312	56	1259	29
<i>Nais elinguis</i>	688	10	74	1	8	1	258	6
<i>Orthocladius</i> sp. G	622	9	142	2	2	<1	256	6
<i>Nais pardalis</i>	320	5	46	1	0	<1	123	3
<i>Amphichaeta americana</i>	181	3	1	<1	1	<1	61	1
<i>Heterotrissocladius hirt</i>	163	2	190	3	0	<1	122	3
Orthoclaadiinae	130	2	7	<1	0	<1	46	1
<i>Stylaria lacustris</i>	72	1	86	1	10	2	58	1
<i>Nais variabilis</i>	66	1	59	1	13	2	46	1
<i>Cricotopus</i> (<i>Cricotopus</i>)	55	1	16	<1	0	<1	24	1
<i>Pelosclex</i> spp.	44	1	149	3	20	4	74	2
<i>Dicerotendipes</i> T3	42	1	19	<1	13	2	25	1
<i>Nais barbata</i>	39	1	3	<1	0	<1	14	<1
<i>Gammarus</i> spp	32	<1	103	2	26	5	56	1
<i>Pisidium nitidum</i>	1	<1	47	1	11	2	21	<1
<i>Tanytarsus</i> spp	10	<1	44	1	0	<1	19	<1
Acarina	10	<1	33	1	17	3	20	<1
<i>Gammarus fasciatus</i>	19	<1	25	<1	13	2	19	<1
<i>Paratanytarsus</i> spp	1	<1	1	<1	9	2	4	<1
Lumbriculidae	15	<1	19	<1	7	1	14	<1
<i>Cryptochironomus</i> spp	10	<1	3	<1	7	1	7	<1
<i>Gyraulius</i> spp	3	<1	16	<1	6	1	9	<1
<i>Procladius</i> spp	14	<1	22	<1	5	1	14	<1
<i>Polypedilum</i> nr. <i>scalaenum</i>	15	<1	1	<1	4	1	7	<1
<i>Slavina appendiculata</i>	22	<1	8	<1	4	1	12	<1
<i>Cricotopus bicinctus</i>	33	<1	8	<1	4	1	15	<1
<i>Chironomini</i>	3	<1	3	<1	3	1	3	<1
<i>Hydroptila</i> spp	11	<1	5	<1	3	1	6	<1
<i>Monodiamesa</i> spp	1	<1	7	<1	3	1	4	<1
<i>Pisidium supinum</i>	5	<1	13	<1	3	1	7	<1
<i>Pisidium</i> spp	1	<1	21	<1	3	1	9	<1
Total Number & Percent	6357	96	5757	97	526	95	4338	96
Total Number Spars	30		32		32		94	

TABLE 3.6-3

Spatial and Temporal Density Distribution of Benthic
Organisms at Pickering GS 'B' - 1981 (No/m² × 10¹)

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O	Row Mean
1	22	171	22	-	41	60	524	32	125
3	473	1086	3	1124	371	473	546	533	576
7	1778	946	-	1225	1127	1394	2270	238	1283
12	1359	289	387	644	663	648	927	540	682
Mean	910	623	138	998	551	644	1067	336	664

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O	Row Mean
1	41	70	41	0	0	48	19	19	30
3	121	124	22	489	57	133	159	372	183
7	768	1997	0	930	83	1143	1314	406	830
12	1473	1968	3102	1371	460	502	917	787	1323
Mean	601	1040	791	698	150	456	602	394	591

October 8, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O	Row Mean
1	0	29	19	54	6	0	0	0	13
3	105	16	6	76	19	35	3	83	43
7	467	117	0	54	60	41	54	19	102
12	102	29	184	35	48	38	22	48	63
Mean	168	48	52	55	33	29	20	37	55

TABLE 3.6-4

Spatial and Temporal Distribution of Benthic Species
Richness at Pickering GS 'B' - 1981

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O	Row Mean
1	5	11	6	-	7	9	24	9	10
3	13	20	1	25	17	12	12	27	16
7	12	16	-	16	16	24	9	20	16
12	13	8	11	11	11	7	16	10	11
Mean	11	4	6	17	13	13	15	17	13

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O	Row Mean
1	4	9	8	0	0	6	5	5	5
3	13	12	6	11	11	6	8	25	12
7	18	29	0	19	10	16	10	13	14
12	11	16	11	21	14	12	16	17	15
Mean	12	17	6	13	9	10	10	15	11

October 8, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O	Row Mean
1	0	5	5	3	1	0	0	0	2
3	7	3	2	6	3	3	1	7	4
7	8	12	0	9	10	6	4	6	7
12	3	6	6	5	9	5	5	9	6
Mean	5	7	3	6	6	4	3	6	5

Taxonomic Diversity

Taxonomic diversity has two components. The first of these, taxonomic richness, is discussed above. The second component, evenness, is a measure of the equitability with which the pool of organisms is partitioned among the taxa. The Shannon-Weiner information statistic incorporates both these components in one measure (Pielou 1974). Diversity indices were calculated for all benthic samples at the Pickering GS 'B' study area, and are displayed in Table 3.6-5. The depth at which maximum diversity occurred increased from July to October; greatest mean diversity in July was at the 1 m depth, in August at the 3 m depth, and in October at the 12 m depth. Mean diversities, like mean taxonomic richness, were generally highest in Transects O, G, and the Pickering GS 'B' discharge location. On average, both taxonomic richness and diversity were low throughout the season at the Pickering GS 'A' discharge spars (Table 3.6-4, 3.6-5). These characteristics had relatively high values at the 1 m depth on this transect despite the occurrence of high water temperatures at this spar (Table 3.6-6).

Distribution of Dominant Benthic Invertebrate Taxa

Distributions of individual dominant taxa (comprising 1% or more of the total zoobenthos collected - see Table 3.6-2) are discussed below.

Oligochaeta

a) *Vejdovskyella comata* was the most common naidid worm in all months' samples. This species was not collected in 1979. In July, it was the most common taxon (41%), but diminished in importance through the August (38%) and October (3%) sampling periods. The greatest abundance of *V. comata* was at the 7 m and 12 m spars (Table 3.6-7), which is unusually deep for naidid worms (Barnes 1968). Otherwise, very little is known on the ecology of this species precluding comment on its dominance in July.

b) Tubificidae

Unidentifiable members of the tubificid family of worms were the second most abundant invertebrates, comprising from 15% (July), and 39% (August), to a peak dominance in October of 56% (Table 3.6-8). Tubificidae are found over a wider range of depths than the Naidae (Barnes 1968), but at Pickering, they reached their greatest abundance at the 7 m and 12 m spars, as did the naidid *V. comata*. Greatest average abundance occurred along Transect E which extends outward from the communities of Fairport and Fairport Beach, which may promote organic

TABLE 3.6-5

Spatial and Temporal Distribution of Shannon-Weiner
Benthic Diversity Indices at Pickering GS 'B' - 1981

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O	Row Mean
1	2.24	2.86	2.52	-	2.57	2.86	2.36	3.12	2.65
3	1.98	1.95	0.00	2.83	2.76	2.86	2.53	3.75	2.33
7	2.13	1.92	-	2.12	2.67	2.10	1.76	3.63	2.33
12	1.49	1.14	1.53	1.60	1.54	0.87	1.29	1.15	1.33
Mean	1.96	1.97	1.35	2.18	2.39	2.17	1.99	2.91	2.16

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O	Row Mean
1	1.55	2.32	2.87	0.00	0.00	1.87	2.25	2.25	1.64
3	3.34	3.07	2.52	2.40	3.04	1.67	1.83	4.03	2.74
7	2.32	2.70	0.00	2.71	2.56	1.83	1.33	1.59	1.88
12	1.50	1.01	1.21	1.88	2.05	1.55	2.06	1.80	1.63
Mean	2.18	2.28	1.65	1.75	1.91	1.73	1.87	2.42	1.97

October 8, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O	Row Mean
1	0.00	2.06	2.25	1.55	0.00	0.00	0.00	0.00	0.73
3	1.51	1.37	1.00	2.09	1.46	0.87	0.00	2.38	1.34
7	0.578	2.53	0.00	2.78	2.86	2.03	1.28	2.58	1.83
12	0.535	2.50	1.26	2.23	3.06	1.90	2.24	2.97	2.09
Mean	0.66	2.12	1.13	2.16	1.85	1.20	0.88	1.98	1.50

1981 Season Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O	Row Mean
1	1.26	2.41	2.55	0.78	0.86	1.58	1.54	1.79	1.75
3	2.28	2.13	1.17	2.44	2.42	1.80	1.45	3.39	2.14
7	1.68	2.38	0.00	2.54	2.70	2.27	1.46	2.60	1.95
12	1.18	1.55	1.33	1.90	2.22	1.44	1.86	1.97	1.68
Mean	1.60	2.12	1.26	1.91	2.05	1.77	1.58	2.44	1.88

TABLE 3.6-6

Bottom Water Temperatures Measured at Benthos
Collection Spars at Pickering GS 'B' - 1981

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	16.7	16.7	26.0	-	16.7	16.0	17.0	17.0
3	14.2	14.2	14.2	13.0	14.0	14.0	15.0	15.0
7	13.8	13.8	-	15.5	12.5	13.0	14.0	14.0
12	13.8	13.8	14.5	14.5	14.5	13.0	13.0	13.0

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	15.0	26.0	25.0	21.0	21.0	19.8	20.0	20.0
3	22.0	19.5	27.5	19.5	18.9	19.0	28.0	19.0
7	19.0	19.0	19.0	18.0	18.5	15.0	15.5	15.5
12	18.9	12.8	19.0	13.5	12.5	12.6	13.5	13.0

October 8, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	7.5	7.5	18.2	7.8	8.5	7.2	7.5	8.0
3	7.0	7.5	14.5	8.5	8.0	7.2	7.5	7.5
7	9.7	10.0	10.0	10.2	10.0	8.5	9.0	10.0
12	9.5	8.7	9.5	10.2	10.0	9.5	9.0	9.5

TABLE 3.6-7

Spatial and Temporal Distribution of *Vejdovskyella comata*
by Per Cent at Pickering GS 'B' - 1981

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	<1	<1	-	<1	0	<1	0
3	<1	5	0	1	<1	1	1	1
7	4	2	-	5	3	5	5	<1
12	2	2	<1	2	2	4	5	3

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	<1	<1	<1	0	0	0	<1	<1
3	<1	<1	0	1	<1	<1	<1	<1
7	<1	4	0	1	<1	3	1	2
12	4	11	2	6	2	<1	3	3

October 8, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	0	<1	0	0	0	0	0
3	0	0	<1	0	0	0	0	0
7	<1	<1	0	<1	0	<1	<1	0
12	0	0	0	0	<1	<1	0	<1

TABLE 3.6-8

Spatial and Temporal Distribution of Tubificidae by
Per Cent at Pickering GS 'B' - 1981

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	<1	0	0	-	0	<1	<1	<1
3	<1	<1	0	<1	<1	<1	1	<1
7	4	4	-	<1	<1	1	6	<1
12	8	<1	<1	0	<1	0	<1	0

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	0	<1	0	0	<1	<1	0
3	<1	<1	0	<1	0	<1	1	<1
7	4	6	0	4	<1	4	9	<1
12	7	<1	21	1	<1	3	3	1

October 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	<1	0	0	<1	0	0	0
3	1	<1	<1	<1	<1	<1	<1	0
7	4	1	0	<1	<1	<1	<1	0
12	1	<1	1	<1	<1	<1	<1	0

enrichment of this area from the sewage treatment plant on Frenchman Bay.

c) *Nais elinguis*, a second naidid worm, were most abundant and widely distributed in July, when they accounted for 10% of the benthic collection. Their numbers and importance (Table 3.6-9) dropped substantially by August and remained low during October. Greatest dominance of *N. elinguis* occurred at the 7 m spars, especially in July at Transect M, the Duffin Creek transect.

d) *Nais pardalis* (Table 3.6-10) was locally dominant at the 3 m spars in July (Transects I, 'B' discharge location) and August (Transect I). None were collected in October.

3) *Peloscoides* spp, another tubificid, was more broadly distributed in a temporal context, with significant representation in all three months of benthos sampling. These worms were most abundant at the 7 m and 12 m spars of most transects except K and O.

f) *Amphichaeta americana*, a rather rare naidid (Brinkhurst 1976, 1978), was found in local concentrations in July only. It was most common at the 3 m spars, and was never found at depths of 1 m.

g) *Stylaria lacustris* was the only naidid which reached maximum numbers in August (Table 3.6-2). Its numbers were lowest in October. Like other naidids, it was most abundant at the 7 m spars of transects to the east of discharge 'A' transect.

h) *Nais variabilis* was the least common naidid to be classed as a dominant taxon. It displayed a patchy distribution: in July, concentrations occurred at the 3 m and 7 m spars of Transects I and the 'B' discharge transect, while no *N. variabilis* were found at 'B' discharge transect during the rest of the sampling. In August, this taxon was also common along Transect E around Frenchman Bay.

Insecta: Diptera

All dipterous taxa decreased in abundance over the period sampled (Table 3.6-1), and all dominant Diptera were midges (Family Chironomidae).

a) *Orthocladus* sp G was the most common insect collected at Pickering in 1981, occurring almost exclusively in July and August (Table 3.6-11), which may reflect an emergence period of late summer. Like other benthic taxa previously discussed, O. sp. G were most common at the 7 m and 12 m spars.

TABLE 3.6-9

Spatial and Temporal Distribution of *Nais elinguis*
by Per Cent at Pickering GS 'B'

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	<1	2	0	0	1	1	14	<1
3	0	3	0	<1	0	1	8	1
7	20	<1	-	2	0	1	32	<1
12	2	0	<1	0	0	<1	<1	0

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	2	<1	0	0	0	0	0
3	<1	1	0	<1	0	<1	0	0
7	6	<1	0	0	0	<1	<1	0
12	<1	0	0	0	0	0	0	0

October 8, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
7	0	0	0	0	1	0	0	0
12	0	0	0	0	0	0	0	<1

TABLE 3.6-10

Spatial and Temporal Distribution of *Nais pardalis*
by Per Cent at Pickering GS 'B' - 1981

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	1	0	-	0	0	0	0
3	0	1	<1	55	16	0	1	3
7	0	0	-	0	10	0	0	0
12	0	0	0	0	0	0	0	0

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	0	0	0	0	0	0	0
3	1	0	0	10	0	0	0	1
7	0	0	0	1	0	0	0	0
12	0	0	0	<1	0	0	0	0

TABLE 3.6-11

Spatial and Temporal Distribution of *Orthocladus* sp. G
by Per Cent at Pickering GS 'B' - 1981

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	1	0	-	0	<1	<1	0
3	<1	6	0	1	1	2	0	<1
7	0	3	-	1	10	11	0	3
12	<1	1	12	13	12	1	2	<1

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	<1	<1	0	0	0	<1	0
3	1	<1	0	1	0	0	0	<1
7	0	8	0	1	<1	1	0	<1
12	0	1	<1	3	1	<1	<1	<1

October 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
12	0	0	0	0	<1	0	0	0

b) "*eterotrissocladius hirtapex*, another orthoclad, appeared to have a similar distribution. There was no occurrence of *H. hirtapex* in October, and in July and August it was most common at the 7 m and 12 m spars (Table 3.6-12).

c) Unidentifiable Orthocladiinae may include immature individuals of other taxa which were identified to a lower level, as well as species for which identification is not yet possible. Most unidentified Orthoclads were collected in July, and the proportion found in August is very small, which promotes the idea that this group is principally composed of immature and thus unidentifiable individuals of known species. The Orthocladiinae are (in general) intolerant to mildly tolerant of chemical and organic pollutants (Mason 1974), but their response to thermal discharges is not as well documented.

d) *Cricotopus* [*Cricotopus*] Members of the genus *Cricotopus* are apparently the most pollution-tolerant orthoclads (Mason 1974). *Cricotopus* at Pickering were most common in the shallow waters (1 m and 3 m spars) during July. None were collected in the Pickering GS 'A' discharge in July or August, and no October samples contained *C. [Cricotopus]*.

e) *Dicrotendipes* T3 was the only dominant chironomid not of the Orthocladiinae. *Dicrotendipes* are of the subfamily Chironominae, tribe Chironomini. The genus is classed as relatively tolerant of pollutants by Mason (1974). None were collected in the discharge 'A' transect. *Dicrotendipes* T3 were most often collected in water less than 12 m deep, and were most abundant at the 3 m spars of transects east of discharge 'A'.

Amphipoda

Gammarus spp. This taxon is probably immature *G. fasciatus*, the only identified species of *Gammarus* at Pickering. If both these taxa were combined, the new classification would be about 40% more abundant. *Gammarus* were found at all depths, but were most common at the 3 m and 7 m spars of Transect I and on the western side of the discharge 'A' along Transect G.

Community - Habitat Relationships of Zoobenthos

Mutual Information Analysis (Orloci 1968, 1969) was used to form assemblages of samples having similar components of taxonomic representation and equitability. Green and Vascotto (1978) and Green (1979) discuss the application of this technique to ecological data, and in particular to lake zoobenthos.

TABLE 3.6-12

Spatial and Temporal Density Distribution of
Heterotrissocladius hirtapex by Per Cent
 at Pickering GS 'B' - 1981

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	<1	0	0	-	0	<1	<1	0
3	3	1	0	4	1	5	1	0
7	5	0	-	1	10	8	0	0
12	0	0	0	0	<1	3	0	0

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	0	0	0	0	0	0	0	0
3	0	1	<1	0	1	0	1	1
7	5	6	0	6	<1	<1	1	1
12	4	2	1	8	2	3	7	4

The analysis was performed separately on the two distinct groups of taxa (Oligochaeta, Chironomidae) after elimination of organisms identified only to family or subfamily. Inadequately identified taxa may introduce substantial bias in the analysis, particularly when they are common (eg, Tubificidae). Assemblage 1 is characterized by a diverse and equitable representation of taxa, for both the oligochaete (Table 3.6-13) and chironomid (Table 3.6-14) analyses. In both cases, the first assemblage is also the most commonly assigned to the benthic samples, representing 57 and 62 samples in the oligochaete and chironomid analyses respectively (Tables 3.6-15, 3.6-16). Distribution of six assemblages with respect to some environmental variables is listed in Table 3.6-17. For each of the two major taxonomic groups, assemblage 1 is the most commonly found on sand-dominated substrates with moderate algal cover (approximately 15%) in shallow water. In October, all samples are represented by assemblage 1 chironomids and oligochaetes, but earlier in the season mostly shallow water samples were classed as assemblage 1 (Tables 3.6-15, 3.6-16). All other chironomid and oligochaete assemblages were most common in July and August, and in deeper water.

Oligochaete assemblages 2 and 5, and chironomid assemblages 2, 4, 5, 7, 8 and 9 were represented in relatively few samples, and little generalization of habitat-community relationships can be made. Oligochaete assemblage 3, representing 12 samples, was most common in July at mid-depth locations with generally high (but variable) amounts of algal cover (Table 3.6-17). Three naidid worms, *V. comata*, *N. elinguis*, and *A. americana*, dominated this assemblage.

V. comata dominates the fourth oligochaete assemblage, which most characterizes samples from the 7 m and 12 m depths in July and August. These samples are also characterized by slightly less sandy substrates and lower algal density than the other common oligochaete assemblages (Table 3.6-17).

Sediment mass lost on ignition (an indication of organic content) is higher at these depths, which may provide more food for the deposit-feeding *V. comata* (see Section 3.1).

Successive chironomid components of benthic samples tend to be more taxonomically individualistic than oligochaete components; only assemblages 1, 3 and 6 are represented in more than five samples. Assemblage 3 is dominated by *Orthocladus* sp. G, unidentified *Heterotrissocladius* species, and *Cricotopus bincinctus*. Samples making up this assemblage are most common early in the season (July), and the unidentified *Heterotrissocladius* larvae may be early instar *H. hirtaper* (Table 3.6-17). This assemblage is represented only at the 3 m

TABLE 3.6-13

OLIGOCHAETE ASSEMBLAGES FORMED BY MUTUAL INFORMATION ANALYSIS
(PER CENT COMPOSITION BY DOMINANT TAXA)

Taxon	Per Cent Representation in Assemblage				
	1	2	3	4	5
<i>V. comata</i>	26	11	42	85	96
<i>N. elinguis</i>	10	<1	25	2	<1
<i>N. pardalis</i>	2	74	7	<1	<1
<i>Pelosclex</i> spp	11	0	1	6	2
<i>A. americana</i>	2	0	11	<1	1
<i>S. lacustris</i>	3	1	3	4	<1
<i>N. variabilis</i>	6	9	6	<1	0
No. samples	57	2	12	17	7

TABLE 3.6-14

CHIRONOMID ASSEMBLAGES FORMED BY MUTUAL INFORMATION ANALYSIS
(PER CENT COMPOSITION BY DOMINANT TAXA)

	1	2	3	4	5	6	7	8	9
<i>Orthocladius</i> sp G	5	4	38	71	32	5	3	95	56
<i>H. hirtapex</i>	7	6	6	1	42	71	5	<1	28
<i>Dicrotendipes</i> T3	7	6	4	1	0	1	0	0	1
<i>Cricotopus</i> (<i>cricotopus</i>)	3	27	2	3	0	0	0	0	<1
<i>Tanytarsus</i> spp	2	2	0	2	5	4	43	<1	4
<i>C. bicinctus</i>	6	8	11	2	0	0	0	0	0
<i>Procladius</i> spp	5	0	0	2	0	6	49	<1	0
<i>Heterotrissocladius</i> spp	<1	2	23	4	0	1	0	<1	0
<i>Parakiefferiella</i> spp	2	10	1	<1	2	2	0	0	2
<i>Thienemannimyia</i> Group	3	0	2	5	0	0	0	<1	2
<i>Paratanytarsus</i> sp 1	4	4	0	0	0	0	0	0	<1
<i>Chironomus</i> spp	4	0	4	0	1	1	0	0	1
<i>Cryptochironomus</i> spp	6	0	0	1	0	1	0	0	1
<i>Polypedilum</i> nr <i>scalaenum</i>	4	0	4	2	2	1	0	0	0
<i>Paratendipes</i> spp	1	2	1	2	1	1	0	0	2
Number of Samples	62	1	7	5	4	7	1	3	5

TABLE 3.6-15

Spatial and Temporal Dominance Distribution of
Benthic Oligochaeta Faunal Assemblages Constructed by Mutual
Information Analysis
Pickering GS 'B' - 1981

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	1	1	1	-	1	1	3	1
3	3	4	1	2	2	3	3	1
7	3	4	4	4	3	4	3	3
12	4	4	1	4	4	5	5	5

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	1	1	1	1	1	1	1	1
3	1	1	1	3	1	1	1	4
7	3	4	4	3	1	4	4	3
12	5	5	4	5	4	1	4	5

October 8, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1

TABLE 3.6-16

Spatial and Temporal Dominance Distribution of
Benthic Chironomidae Assemblages Constructed by Mutual
Information Analysis
Pickering GS 'B' - 1981

July 7, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	1	3	1	-	1	1	2	1
3	5	4	1	1	1	1	3	1
7	6	4	4	3	9	9	1	4
12	2	3	8	8	8	5	4	3

August 10, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	1	1	1	1	1	1	1	1
3	3	1	1	3	1	1	1	1
7	6	9	9	6	1	1	1	1
12	6	5	7	9	5	6	6	6

October 8, 1981 Spar Depth (m)	E	G	'A' Dis	I	'B' Dis	K	M	O
1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1

TABLE 3.6-17

HABITAT ASSOCIATIONS OF OLIGOCHAETE (O_i) AND
CHIRONOMID (C_i) ASSEMBLAGES AT PICKERING,
MEANS AND (COEFFICIENT OF VARIATION)

Assemblage	Day*	Depth (m)	Sand (%)	Algal Cover (%)
O_1	244 (70.0)	3.8 (107.3)	64.2 (95.4)	15.2 (168.0)
O_3	195 (10.4)	5.2 (44.8)	50.8 (96.8)	21.7 (154.3)
O_4	227 (18.4)	9.4 (37.6)	46.8 (98.1)	6.2 (94.3)
C_1	245 (16.4)	4.4 (86.0)	65.5 (62.7)	15.3 (17.2)
C_3	193 (10.1)	5.9 (77.3)	86.5 (43.6)	17.1 (199.0)
C_6	216 (7.2)	9.9 (27.0)	43.6 (112.2)	1.6 (179.5)

* July sample = 181, August = 222, October = 281

and 7 m depths, in areas where sand makes up roughly 50% of the substrate, and algal cover is moderately high. These chironomids may function as collector-gatherers of particulate plant detritus (Merritt and Cummins, 1978).

Chironomid assemblage 6, like assemblage 3, represents seven samples. However, this assemblage is more common later in the season in deeper water (Table 3.6-17). The inorganic substrate for these samples is similar to that where assemblage 3 occurs, but the algal cover is much reduced. *H. hirtapex* dominates assemblage 6 samples with a mean representation of 71% (Table 3.6-14). Other *Heterotrissocladius* species are often found in mesothermal (15-30°C) waters (Simpson and Bode 1980) but chironomid assemblages exhibiting *Heterotrissocladius* dominance (3, 4, 5, 8, 9) are rarely found in shallow water or thermally elevated discharge samples (Table 3.6-6) at Pickering (Table 3.6-16).

3.7 Fish

Ichthyoplankton

Species Composition

The larval fish caught at Pickering represented 11 taxa of which 10 were distinct species (Appendix VIII). Alewife was the most abundant larval fish species, accounting for 77% of the total catch (Table 3.7-1). Rainbow smelt was second in abundance, representing 18% of the catch, followed by carp with 4% of the catch. The remaining eight taxa collectively represented 1% of the catch. A total of 3 479 eggs were collected and consisted of alewife and smelt eggs in approximately a 10:1 ratio (Table 3.7-1). Complete data are presented in Appendix VII.

The composition of fish eggs and larvae in this study was similar to that recorded for the 1979 aquatic survey, although greater numbers of organisms were collected during the latter study (Ontario Hydro Research Division Report No 82-266-K). Larval alewife contribution to the overall larval catch was greater for this survey than for the 1979 survey, while the proportion of larval smelt was lower. However, this shift in the relative proportions of larval smelt and alewife should not be considered abnormal, since previous larval fish sampling in the Pickering area has yielded catches composed of over 90% larval alewife (Ontario Hydro Research Division Reports No 77-152-K, 78-322-K and 81-211-K).

TABLE 3.7-1

Summary of Taxal Composition of Fish Eggs and Larvae
Caught at Pickering GS 'B' - 1981
(Pickering Larval White Fish Data Included)

Taxon	Eggs		Larvae	
	#	%	#	%
Alewife	3163	91	4937	77
Rainbow Smelt	316	9	1118	18
Carp	-	-	267	4
Gizzard Shad	-	-	26	<1
Johnny Darter	-	-	8	<1
Cyprinidae	-	-	5	<1
Slimy Sculpin	-	-	5	<1
Yellow Perch	-	-	3	<1
Mottled Sculpin	-	-	2	<1
White Sucker	-	-	3	<1
Round Whitefish	-	-	1	<1
Totals	3479	100	6375	100
# of Taxa	2		11	

Abundance and Distribution

Smelt

Figure 3.7-1 shows the seasonal abundance of fish eggs and larvae caught during lake tows at Pickering. Sampling for the larval whitefish study (April 10 to May 14) produced low numbers of smelt eggs and larvae. The maximum number of smelt eggs (118) were collected on May 5, and preceded the peak in larval smelt abundance (372) by two weeks.

Smelt eggs were collected along each of the transects sampled and in the Pickering GS 'A' forebay. Highest densities ($>100/1000\text{ m}^3$) were recorded on Transect G (near Frenchman Bay) on May 5 and 19, the forebay on May 11 and the Rouge River on May 5 (Table 3.7-2). These data suggest that for smelt, shore-spawning may occur through most of the study area. Smelt eggs were not found after June 11.

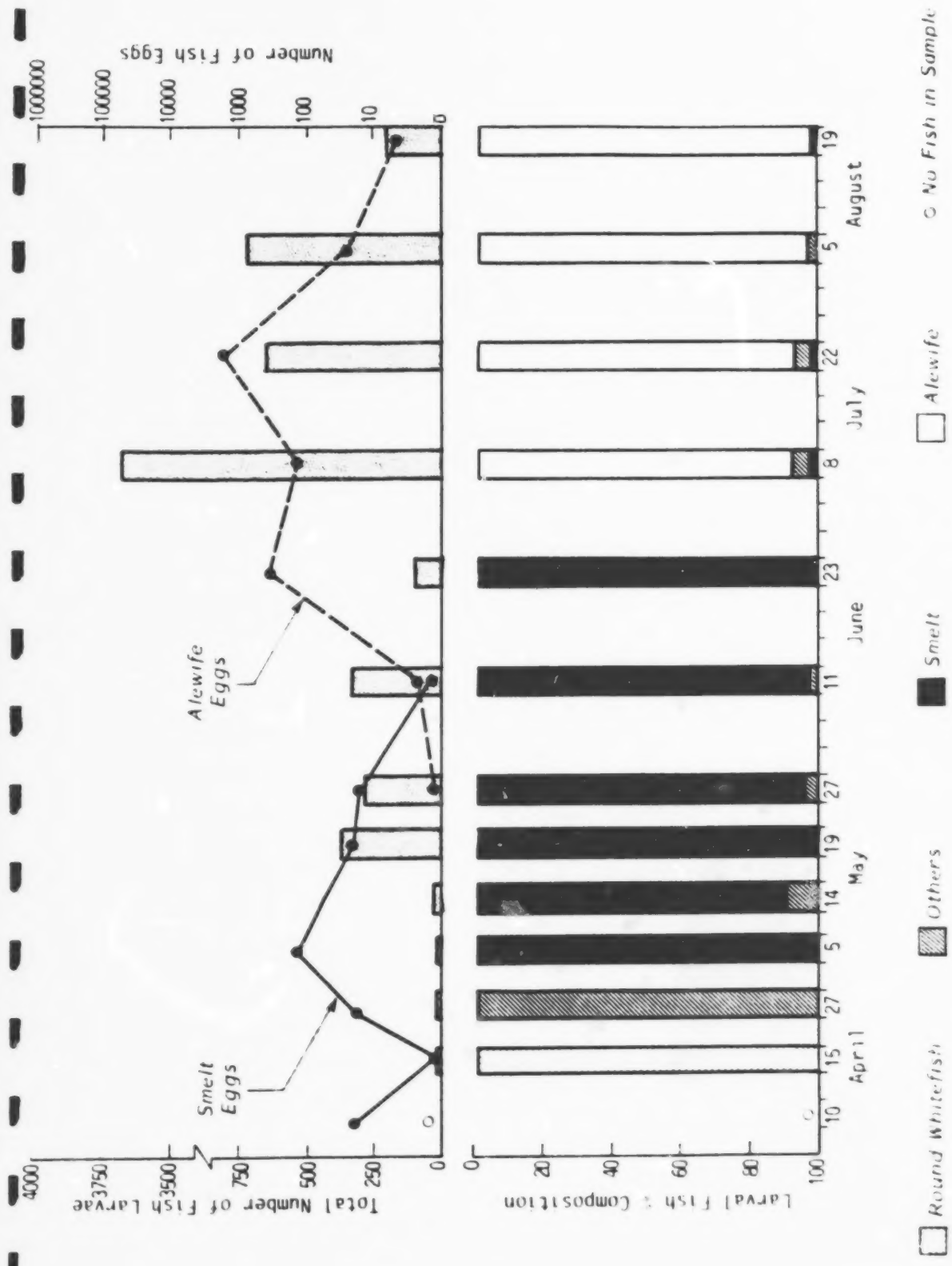


FIGURE 3.7-1
SEASONAL SPECIES COMPOSITION AND ABUNDANCE OF FISH EGGS AND LARVAE
CAUGHT AT PICKERING GS 'B', 1981 (PICKERING LARVAL WHITEFISH DATA INCLUDED)

TABLE 1. 1-2-3

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(1) capture better evidence.

Larval smelt were about 6.0 mm in total length on May 19 (Figure 3.7-2, Appendix IX), and were concentrated near the Pickering GS 'B' discharge location in densities exceeding 1000 larvae/1000 m³ at the 1 m and 3 m isobaths (Transect I, Figure 3.7-3). The large concentrations of smelt larvae indicates that lake spawning probably occurs in the vicinity of the Pickering GS 'B' discharge location, since the majority of smelt eleutheroembryos (= early post-hatch larvae) had yolk-sacs attached.

Larval smelt were present in surface waters on all sampling dates except one (August 5) between May 5 and August 19. Numbers of larval smelt declined sharply from 940 to 125 between the June 23 and July 8 sampling periods (Figure 3.7-1). During the same time interval mean total length of smelt larvae increased from 6.6 mm to 21.6 mm (Figure 3.7-2). The apparent reduction in abundance of smelt larvae may thus be related to avoidance of the sampling gear by larger larvae, although a critical size range over which smelt larvae initiate net avoidance has not been determined. An alternate explanation is that larger smelt larvae may concentrate closer inshore along sand and gravel beaches (Scott and Crossman, 1973). In this study limited numbers (<15) of large larval smelt (mean total length 39.3 mm) were found close inshore at the 1 m depth contour along transects I and M on August 19.

No obvious onshore-offshore distributional pattern was observed for smelt larvae less than 7.0 mm total length (Figure 3.7-3). Larvae were present in highest densities along Transects M and I on May 19, Transects M, K, I and G on May 27 and Transects I and G on June 11. The density of catchable smelt larvae was substantially reduced along all transects except E and O by June 23. Smelt larvae were not very abundant in forebay samples, with the maximum density recorded on May 21 (125/1000 m³).

Alewife

Alewife eggs were collected in inshore surface waters on all sampling dates between May 27 and August 19, inclusive. The total density of alewife eggs ranged from 1/1000 m³ on May 27 to 925/1000 m³ on July 22 (Table 3.7-2). An early peak in alewife egg density occurred on June 23 when the total density reached 212/1000 m³ (Figure 3.7-1, Table 3.7-2). The implication of this double surge in alewife egg abundance is not clear. An examination of mean daily water temperatures for June and July in the vicinity of Pickering GS 'B' discharge location shows that a trend of sharply rising water temperatures preceded both alewife egg abundance peaks (June 23 and July 22) by approximately 3 to 5 days (Figure 3.1.3-1). The mean water temperature rose from 8.7°C to 13.6°C on the first occasion and from 5.6°C

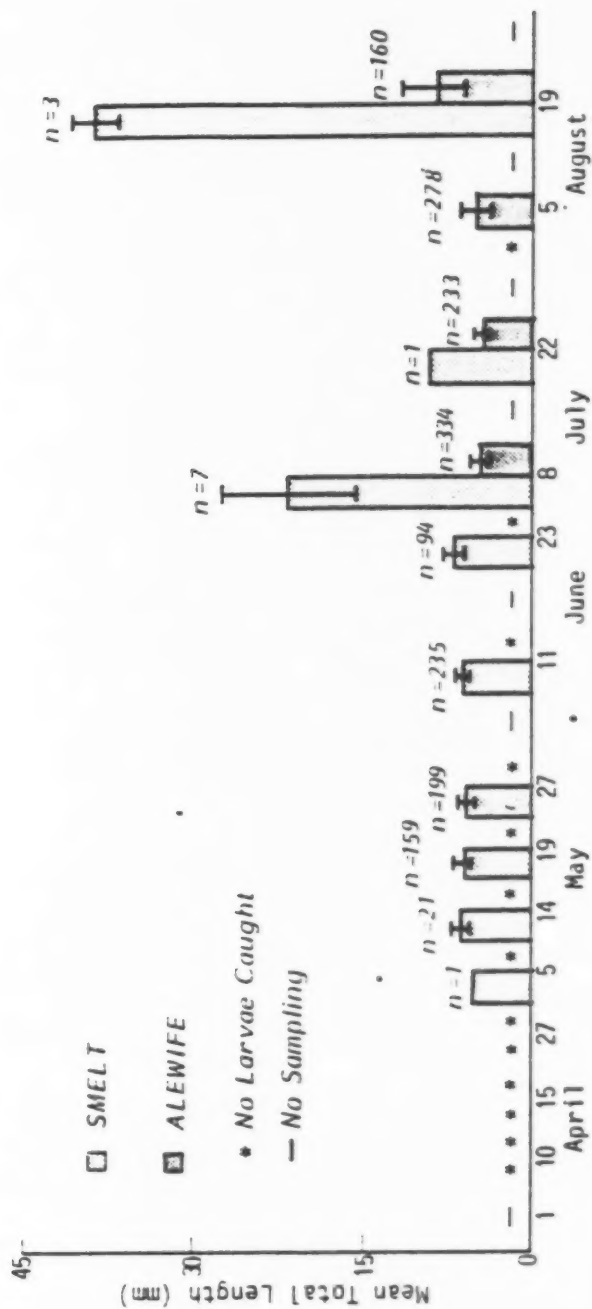


FIGURE 3.7-2
 MEAN TOTAL LENGTHS ($\pm$ S.D.) OF LARVAL SMELT AND ALEWIFE
 CAUGHT IN FOREBAY SETS AND LAKE TOWS
 (PICKERING LARVAL WHITEFISH DATA INCLUDED)
 PICKERING CS 'B' - 1981

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83-193

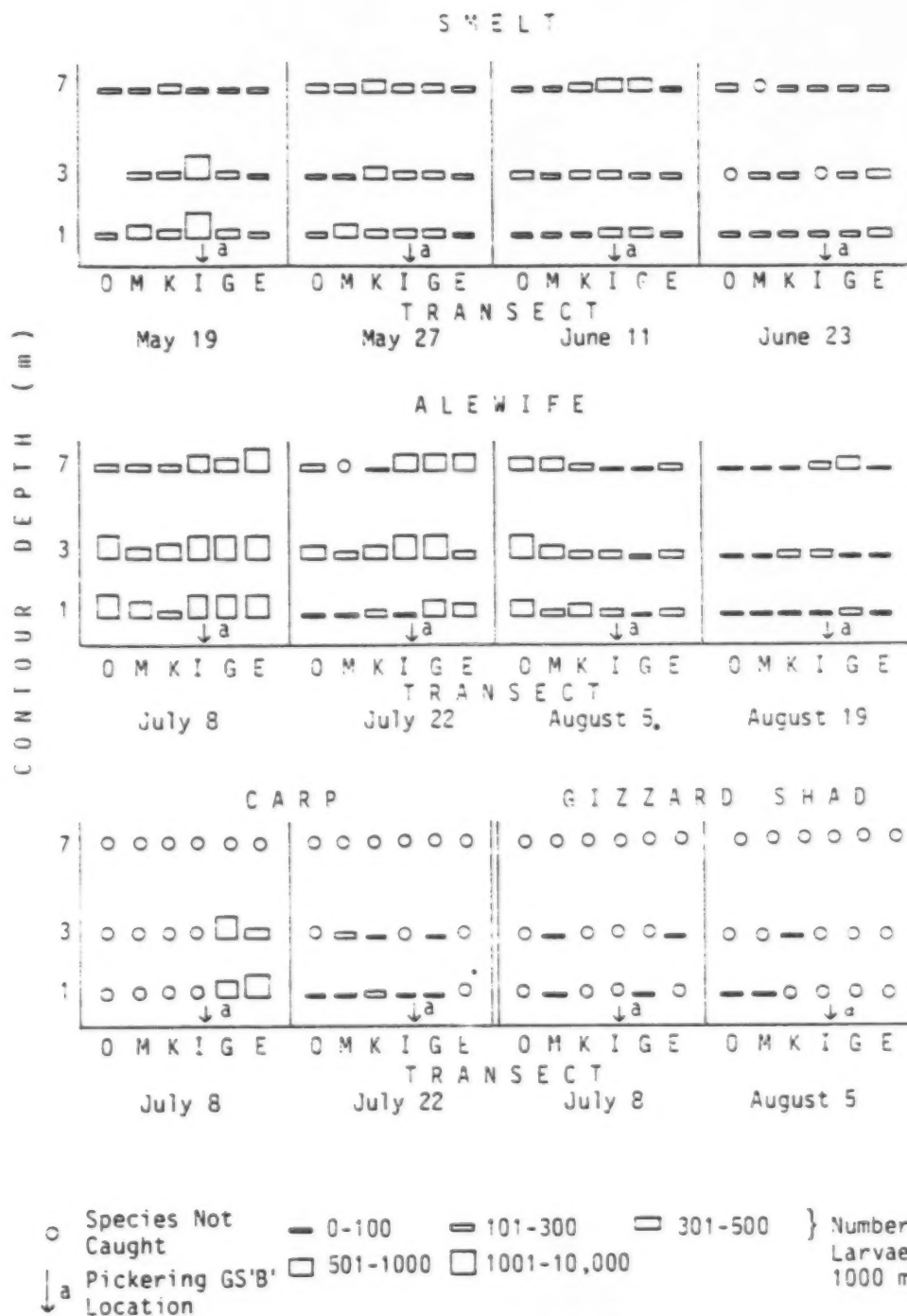


FIGURE 3.7-3
 SPATIAL DISTRIBUTION OF LARVAL SMELT, ALEWIFE, CARP AND
 GIZZARD SHAD DURING PERIODS OF PEAK DENSITY AT PICKERING
 GS 'B', 1981 (LARVAL WHITEFISH DATA NOT INCLUDED)

to 14.1°C on the second occasion. It is feasible that the alewife eggs collected on June 23 and July 22 were spawned during the prior warming sequences noted above, since incubation time of alewife eggs exposed to similar temperature regimes ranges from 6 to 10 days (Edsall, 1970). However, on both occasions rapid decreases in mean water temperature followed the warming trends. These fluctuating water temperatures may have resulted in some alewife egg mortality, since alewife hatching success is poor at temperatures below 10°C (Edsall, 1970).

Major concentrations of alewife eggs occurred along Transects E, G and I on June 23, July 8 and July 22, and in forebay samples on July 22 (Table 3.7-2). Maximum density of 9322/1000 m³ was found at the 7 m depth along Transect E on July 22. Surface waters at the 1 m, 3 m and 7 m isobaths along Transects K, M and O contained low densities of alewife eggs. During periods of high alewife egg abundance, a general trend of increasing egg density with distance from shore (up to the 7 m depth contour) was observed (Table 3.7-2) along Transects E and G.

Abundance of larval alewife was maximal on July 8, when 3432 larvae were captured in surface tows (Figure 3.7-1). Alewife larvae were absent from surface waters on earlier sampling dates. The large catch of alewife larvae on July 8 was distributed over the entire sampling area, with a greater abundance of larvae recorded along Transects E, G, I and O than along Transects M and K (Figure 3.7-3). With the exception of Transect E, offshore surface waters (7 m isobath) contained higher larval alewife densities than inshore (1 m isobath) waters.

Larval alewife distribution was noticeably different on subsequent sampling dates. On July 22 densities of alewife larvae were generally lower at all sampling locations with greatest abundance found at the 3 m depth contour of Transects G and I. Apart from Transects G and E, inshore surface waters contained reduced quantities of larvae, while at the 7 m isobath larval densities remained moderately high (700/1000 m³) at Transects G, E and I (Figure 3.7-3).

By comparison the distribution pattern which existed on August 5 was almost the reverse situation to that of July 22. Highest densities of alewife larvae were recorded along Transects O (with a maximum density of 1760/1000 m³ at the 3 m isobath), M and K, whereas the densities of larvae at Transects E, G and I were substantially reduced from former levels (Figure 3.7-3).

On the last sampling date (August 19) a general decline in larval alewife densities was recorded. Only surface waters at the 3 m and 7 m isobaths of Transects K and I, respectively, contained alewife larvae in densities exceeding 200/1000 m³ (Appendix X).

The mean total length of alewife larvae remained relatively consistent (near 4.5 mm) over the first three sampling periods but increased to 8.7 mm by August 19, corresponding with the decrease in larval alewife density outlined above.

Other Larval Fish

One larval round whitefish was caught during a bottom tow at the 7 m isobath along Transect K on April 15. Despite weekly sampling efforts no additional round whitefish larvae were collected (Appendix XI).

Carp larvae were relatively abundant inshore only at the 1 m and 3 m depth contours of Transects G and E on July 8, with densities ranging from 315/1000 m³ to 1245/1000 m³ (Figure 3.7-3). By July 22 larval carp densities on Transects G and E had declined to <10/1000 m³ while some larvae appeared in the inshore waters of the four other sampling transects (Figure 3.7-3).

Gizzard shad larvae were never caught in high densities; however, a few larvae (<85/1000 m³) were collected in inshore areas of Transects G, E and M on July 8, and Transects O, M and K on August 5 (Figure 3.7-3).

The remaining larval fish species, including yellow perch and white sucker, were collected in low numbers.

Juvenile and Adult Fish

Species Composition and Abundance

The total catch of juvenile and adult fish in the vicinity of Pickering GS 'B' during 1981 was 35 079, and consisted of 42 taxa of which 39 were identified to the species level (Table 3.7-3). Complete data are presented in Appendix VII and a list of the scientific names of the species caught are in Appendix XII. Fish catches made during the two previous Pickering GS 'B' preoperational aquatic surveys were less than the 1981 fish catch (19 025 and 22 111 in 1979 and 1980 respectively) although the fishing effort did not vary over the three years of experimental fishing (Ontario Hydro Research Division Report Nos 82-266-K and 82-460-K). The smaller fish catches in 1979 and 1980 were mainly due to lower alewife catches.

TABLE 3.7-3

Total Fish Catch - All Gear Types
Pickering GS 'B' - 1981

Species	Beach Seines		Trap Nets		Gill Nets		Total All Gear Types	
	#	%	#	%	#	%	#	%
Alewife	2 648	60.4	8 264	55.8	12 534	78.9	23 446	66.8
Brown Bullhead	107	2.4	5 057	34.2	76	0.5	5 240	14.9
Smelt	740	16.9	608	4.1	1 145	7.2	2 493	7.1
White Sucker	36	1.0	309	2.1	842	5.3	1 187	3.4
Gizzard Shad	474	10.8	6	<0.1	456	2.9	936	2.7
Yellow Perch	3	<0.1	330	2.2	166	1.0	499	1.4
White Perch	36	1.0	98	0.7	173	1.1	307	0.9
Round Whitefish	0	0.0	0	0.0	158	1.0	158	0.5
White Bass	3	<0.1	31	0.2	91	0.6	125	0.4
Emerald Shiner	84	1.9	0	0.0	0	0.0	84	0.2
Spottail Shiner	88	2.0	0	0.0	0	0.0	88	0.2
Longnose Dace	57	1.3	0	0.0	0	0.0	57	0.2
Splake	0	0.0	0	0.0	67	0.4	67	0.2
Brown Trout	0	0.0	1	<0.1	64	0.4	65	0.2
Pumpkinseed	25	0.6	25	0.2	0	0.0	50	0.1
Smallmouth Bass	2	<0.1	25	0.2	20	0.1	47	0.1
Carp	7	0.2	20	0.1	14	0.1	41	0.1
Rainbow Trout	2	<0.1	0	0.0	36	0.2	38	0.1
Golden Shiner	21	0.5	0	0.0	0	0.0	21	<0.1
Slimy Sculpin	18	0.4	0	0.0	0	0.0	18	<0.1
Yellow Pickerel	0	0.0	5	<0.1	16	0.1	21	<0.1
Rock Bass	1	<0.1	14	0.1	3	<0.1	18	<0.1
Log Perch	13	0.3	0	0.0	0	0.0	13	<0.1
Freshwater Drum	1	<0.1	0	0.0	6	<0.1	7	<0.1
Coho Salmon	0	0.0	0	0.0	9	<0.1	9	<0.1
Northern Pike	0	0.0	0	0.0	6	<0.1	6	<0.1
Lake Chub	2	<0.1	0	0.0	3	<0.1	5	<0.1
Fathead Minnow	5	0.1	0	0.0	0	0.0	5	<0.1
American Eel	0	0.0	5	<0.1	0	0.0	5	<0.1
Mottled Sculpin	3	<0.1	0	0.0	0	0.0	3	<0.1
Longnose Sucker	0	0.0	0	0.0	5	<0.1	5	<0.1
Chinook Salmon	2	<0.1	0	0.0	0	0.0	2	<0.1
Common Shiner	2	<0.1	0	0.0	0	0.0	2	<0.1
Bluntnose Minnow	2	<0.1	0	0.0	0	0.0	2	<0.1
Cottidae	2	<0.1	0	0.0	0	0.0	2	<0.1
Johnny Darter	1	<0.1	0	0.0	0	0.0	1	<0.1
Spotfin Shiner	1	<0.1	0	0.0	0	0.0	1	<0.1
Longnose Gar	0	0.0	1	<0.1	0	0.0	1	<0.1
Cisco	0	0.0	0	0.0	1	<0.1	1	<0.1
Salmonidae	0	0.0	0	0.0	1	<0.1	1	<0.1
Sea Lamprey	0	0.0	0	0.0	1	<0.1	1	<0.1
Centrarchidae	0	0.0	0	0.0	1	<0.1	1	<0.1
Total	4 386		14 799		15 894		35 079	
(Number of Taxa)	(29)		(16)		(25)		(42)	

Alewife was the most abundant fish species caught, representing 67% of the overall fish catch. Other fish species contributing to more than 1% of the total catch included brown bullhead (15%), smelt (7%), white sucker (3%), gizzard shad (3%), and yellow perch (1%) (Table 3.7-3). Round whitefish accounted for 0.5% of the catch, while the total contribution of salmonids was 0.4%, consisting of 67 splake, 65 brown trout, 9 coho salmon, 2 chinook salmon and 1 unidentified salmonid. A single sea lamprey was captured by gill net.

Distribution of the fish catch among the three gear types was: gill net - 45%, trap net - 42%, and beach seine - 13%. The total beach seine fish catch was composed of 28 species and 1 unidentified cottid, with the greatest number of species (10) being members of the cyprinid family. The total trap net catch contained 16 species representing mainly percids, catostomids and centrarchids. Brown bullhead comprised 34% of the overall trap net catch, and was second in abundance to alewife (56%). Twenty-three (23) species were identified in gill net catches, which were composed primarily of alewife (79%), smelt (7%), white sucker (5%) and gizzard shad (3%).

Spatial and Temporal Distribution

Table 3.7-4 summarizes the distribution of major fish species caught by all three fishing methods with respect to the four locations sampled. The combined catch at Pickering GS 'A' discharge was 14 429 fish, and greatly exceeded the catches at the other locations.

Alewife dominated the catch at all four sites. Brown bullhead were captured at all locations but were more prevalent at Pickering GS 'A' discharge and Duffin Creek. The number of taxa was relatively constant from one location to another, ranging from 27 at both Pickering GS 'A' and 'B' discharge locations to 31 at Duffin Creek.

Alewife predominated in catches associated with each fishing gear type at all sampling locations except Duffin Creek, where the trap net catch of brown bullhead (1 764) exceeded that of alewife (1 085). Alewife catches were highest in trap nets set at Pickering GS 'A' discharge and in gill nets placed at the Pickering GS 'B' discharge location. Alewife caught by beach seine were most numerous in Pickering GS 'A' discharge with fewest caught at Simcoe Point.

Brown bullhead were caught primarily in trap nets with highest catches at Pickering GS 'A' discharge and lowest at the Pickering GS 'B' discharge location. Smelt were collected in moderate numbers by each gear type at all locations except

TABLE 3.7-4

Total Fish Catch - By Location
Pickering GS 'B' - 1981

Fish Taxa	Pickering 'A' Discharge		Pickering 'B' Discharge Location		Duffin Creek		Simcoe Point	
	#	%	#	%	#	%	#	%
Alewife	9 633	66.8	5 239	72.7	3 925	52.0	4 649	78.8
Brown Bullhead	2 859	19.8	241	3.3	1 797	23.8	343	5.8
Smelt	348	2.4	569	7.9	1 074	14.2	503	8.5
White Sucker	196	1.4	331	4.6	396	5.2	274	4.6
Gizzard Shad	446	3.1	448	6.2	30	0.4	11	0.2
Yellow Perch	195	1.4	245	3.4	42	0.6	17	0.3
White Perch	274	1.9	13	0.2	18	0.2	2	<0.1
Round Whitefish	71	0.5	21	0.3	56	0.7	10	0.2
White Bass	97	0.7	7	0.1	15	0.2	6	0.1
Emerald Shiner	44	0.3	2	<0.1	37	0.5	1	<0.1
Spottail Shiner	45	0.3	8	0.1	28	0.4	7	0.1
Longnose Dace	6	<0.1	20	0.3	16	0.2	15	0.3
Splake	21	0.1	20	0.3	9	0.1	17	0.3
Brown Trout	46	0.3	6	<0.1	7	0.1	6	0.1
Pumpkinseed	38	0.3	0	0.0	6	<0.1	4	<0.1
Smallmouth Bass	37	0.3	2	<0.1	7	0.1	0	0.0
Carp	22	0.2	6	<0.1	12	0.2	1	<0.1
Rainbow Trout	12	0.1	9	0.1	10	0.1	7	0.1
Golden Shiner	0	0.0	0	0.0	21	0.3	0	0.0
Slimy Sculpin	0	0.0	8	0.1	5	<0.1	5	<0.1
Yellow Pickerel	18	0.1	1	<0.1	1	<0.1	1	<0.1
Rock Bass	2	<0.1	1	<0.1	9	0.1	6	0.1
Log Perch	0	0.0	0	0.0	11	0.1	2	<0.1
Freshwater Drum	3	<0.1	2	<0.1	0	0.0	2	<0.1
Coho Salmon	7	<0.1	1	<0.1	1	<0.1	0	0.0
Northern Pike	0	0.0	3	<0.1	1	<0.1	2	<0.1
Lake Chub	0	0.0	0	0.0	0	0.0	5	<0.1
Fathead Minnow	0	0.0	0	0.0	4	<0.1	0	0.0
American Eel	3	<0.1	0	0.0	2	<0.1	0	0.0
Mottled Sculpin	0	0.0	1	<0.1	0	0.0	2	<0.1
Longnose Sucker	0	0.0	2	<0.1	0	0.0	3	<0.1
Chinook Salmon	2	<0.1	0	0.0	0	0.0	0	0.0
Common Shiner	2	<0.1	0	0.0	0	0.0	0	0.0
Bluntnose Minnow	0	0.0	0	0.0	2	<0.1	0	0.0
Cottidae	0	0.0	1	<0.1	0	0.0	1	<0.1
Johnny Darter	0	0.0	0	0.0	1	<0.1	0	0.0
Spotfin Shiner	0	0.0	0	0.0	1	<0.1	0	0.0
Longnose Gar	0	0.0	0	0.0	1	<0.1	0	0.0
Cisco	1	<0.1	0	0.0	0	0.0	0	0.0
Salmonidae	0	0.0	1	<0.1	0	0.0	0	0.0
Centrarchidae	1	<0.1	0	0.0	0	0.0	0	0.0
Sea Lamprey	0	0.0	0	0.0	0	0.0	1	<0.1
Total	14 429		7 208		7 545		5 903	
(Number of Taxa)	(27)		(27)		(31)		(28)	

Pickering GS 'A' discharge, where they were absent in trap nets and present in low abundance in beach seine hauls.

White sucker, round whitefish and white perch catches were greatest in gill nets, for all locations sampled. Gizzard shad were not caught in trap net sets at all locations except Duffin Creek, where six shad were collected. A large gizzard shad catch (429) was recorded at Pickering GS 'A' discharge in gill nets, while 438 shad were captured in beach seine hauls at the Pickering GS 'B' discharge location. Yellow perch catches were highest in trap nets set in the Pickering GS 'A' discharge (150) and the Pickering GS 'B' discharge location (154) (Table 3.7-5).

In general the distribution of adult and juvenile fish in the nearshore area adjacent to the proposed Pickering GS 'B' site resembled fish distributions identified in previous reports. Fish species which frequent the Pickering GS 'A' discharge area in moderate to high abundance over the sampling season (May to November) are primarily littoral zone species and include brown bullhead, white perch, white bass, pumpkinseed, smallmouth bass and yellow pickerel (Tables 3.7-4, 3.7-5). These results are consistent with earlier conclusions concerning fish distribution in the Pickering area (Ontario Hydro Research Division Reports No 80-226-K, 82-266-K).

The pelagic schooling fish, alewife, was present in the study area throughout the study period. It occurred in highest densities in June and July and was only found in low numbers after October. This species showed a preference for the discharge locations (Transects E and G) during their period of maximum occurrence in June and July (Figures 3.7-4 and 3.7-5). Gill net catches of alewife at the Pickering GS 'B' discharge location were consistently higher than they were at the Pickering GS 'A' discharge. This was two to three weeks prior to the period when maximum larval alewife concentrations were observed indicating that the presence of large numbers of adult and juvenile alewife at the discharge locations in June and July was probably associated with spawning. Larval alewife densities were also highest along Transects E and G at the two discharge locations during their peak abundance period.

Brown bullhead were collected in the study area between May and September. They appeared to congregate around the Pickering GS 'A' discharge in July, when highest catch per unit effort by trap nets (CUE = 436) was obtained, as well as in September (Figure 3.7-5). In May and August brown bullhead were found in largest numbers at Duffin Creek. Brown bullhead were captured in low numbers in the Pickering GS 'A' discharge during the 1979 and 1980 sampling periods, when the maximum CUE was 40 and 70+, respectively (Ontario Hydro Research Division Report

TABLE 3.7-5

Spatial Distributions of Major Fish Species Caught by
Each Fishing Method at Pickering GS 'B' - 1981

	Pickering 'A' Discharge Location				Pickering 'B' Discharge Location				Duffin Creek				Simcoe Point			
	BS	TN	GN	Total	BS	TN	GN	Total	BS	TN	GN	Total	BS	TN	GN	Total
Alewife	1421	5208	3004	9633	386	864	3989	5239	518	1085	2322	3925	323	1107	3219	4649
Brown Bullhead	43	2757	59	2859	0	235	6	241	27	1764	6	1797	37	301	5	343
Smelt	2	0	346	348	213	79	277	569	255	476	343	1074	270	54	179	503
White Sucker	5	42	149	196	1	41	289	331	27	149	220	396	3	87	184	274
Gizzard Shad	17	0	429	446	438	0	10	448	12	6	12	30	6	0	5	11
Yellow Perch	0	150	45	195	3	154	88	245	0	16	26	42	0	10	7	17
White Perch	33	88	153	274	0	2	11	13	3	7	8	18	0	1	1	2
Round Whitefish	0	0	71	71	0	0	21	21	0	0	56	56	0	0	10	10
Others	126	87	194	407	43	7	51	101	134	29	44	207	39	7	49	95
Total	1647	8332	4450	14,429	1084	1382	4742	7208	976	3532	3037	7545	678	1567	3659	5904
Number of Taxa	(27)				(27)				(31)				(28)			

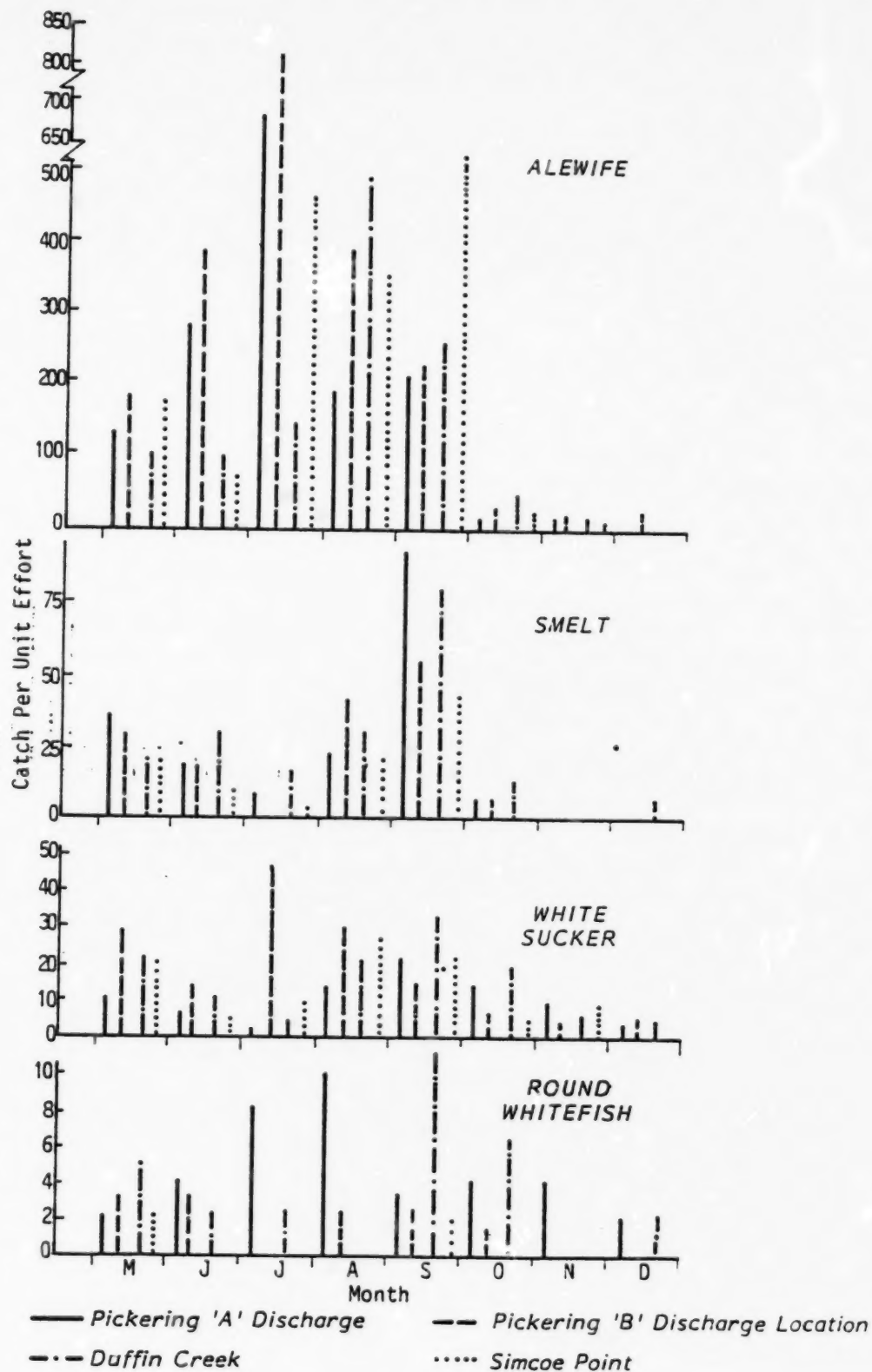


FIGURE 3.7-4

SEASONAL CATCH PER UNIT EFFORT OF ALEWIFE,
 SMELT, WHITE SUCKER AND ROUND WHITEFISH
 CAUGHT BY GILL NET (3m + 12m SETS COMBINED)
 PICKERING GS 'B', 1981

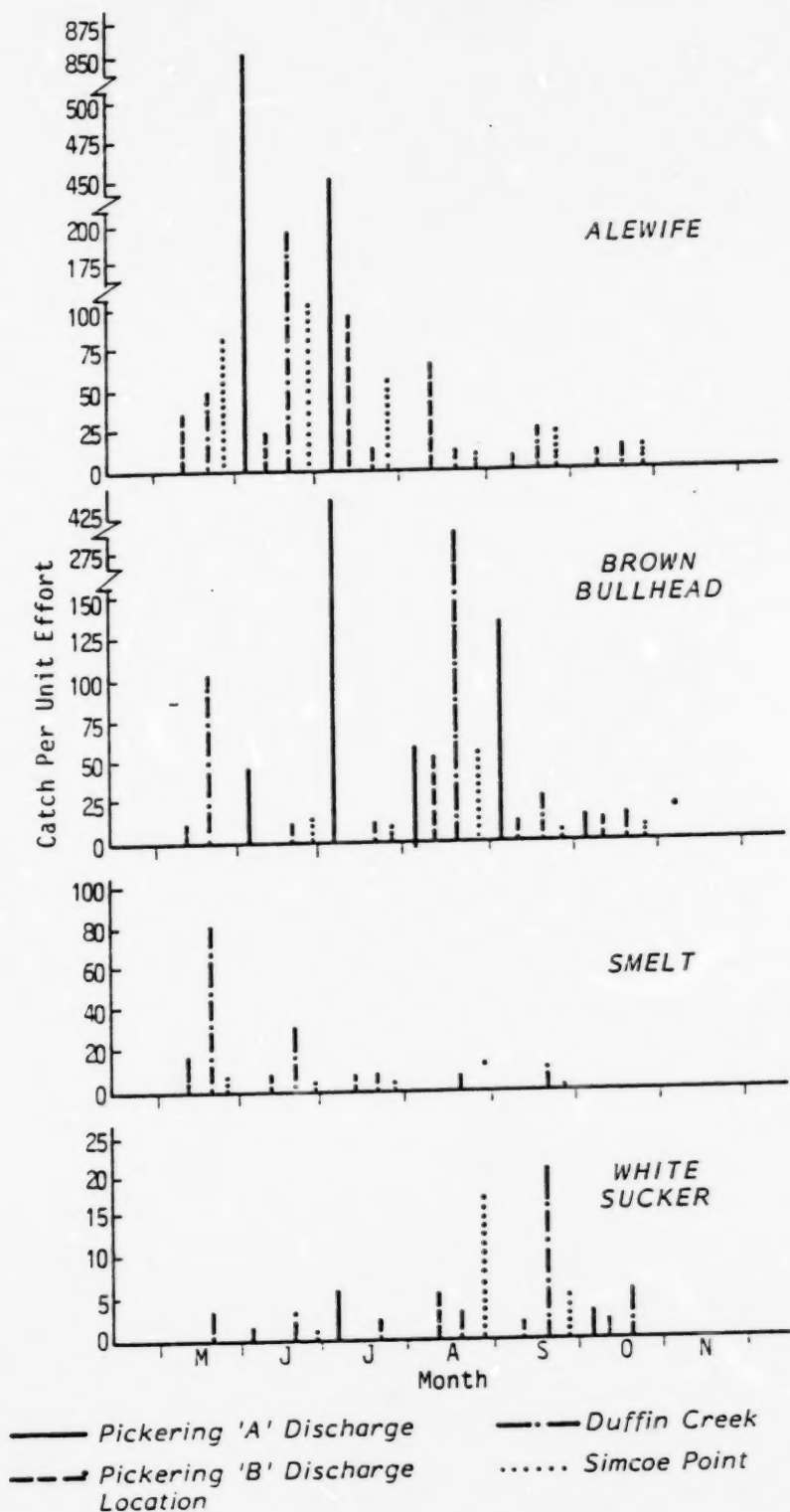


FIGURE 3.7-5
 SEASONAL CATCH PER UNIT EFFORT OF ALEWIFE,
 BROWN BULLHEAD, SMELT AND WHITE SUCKER
 CAUGHT BY TRAP NET - PICKERING GS 'B', 1981

Nos 82-266-K and 82-460-K). During the three years of postoperational aquatic study at Pickering GS 'A', 1974-1976, very high catches of brown bullhead were recorded in the Pickering GS 'A' discharge area, with maximum CUE values ranging from 1 000 to 5 000 (Ontario Hydro Research Division Reports No 75-192-H, 76-315-K and 77-442-K). The highest catch per unit effort for this species in 1981 was 436, and may indicate that brown bullhead are regaining predominance in the Pickering GS 'A' discharge.

Smelt were caught in relatively low numbers throughout the sampling period with highest numbers taken in September. At this time they were most abundant at the Pickering GS 'A' discharge where the catch per unit effort by gill nets was 93. This situation is anomalous and did not occur during the 1979 and 1980 aquatic surveys (Ontario Hydro Research Division Report Nos 82-266-K and 82-460-K). It is likely that the normal spring peak in smelt abundance was present but not adequately sampled.

White sucker were caught throughout the sampling season. Between May and August, largest numbers were collected at the Pickering GS 'B' discharge location (Figure 3.7-4) where maximum catch per unit effort by gill net (CUE = 56) was obtained in July. During the May to August period lowest numbers were consistently caught at the Pickering GS 'A' discharge possibly indicating an avoidance of the warmer discharge waters during the summer months. In the fall, white sucker were most abundant at Duffin Creek.

Three-way analysis of variance performed for alewife smelt and white sucker captured in gill nets demonstrated that significant interactions occurred between the sampling months, transects and depth contours ($P < 0.01$). For alewife only the temporal variable (month) showed significant differences, and the depth contour versus month interaction term was significant ($P < 0.01$) (Appendix XIII). All variables and interaction terms were significant ($P = < 0.01$) in the case of white sucker, while transect and transect versus month terms were significant ($P < 0.01$) with respect to smelt (Appendix XIII). These results indicate that the spatial and temporal distribution of species such as alewife smelt and white sucker can be quite variable and that there is a strong tendency for seasonal effects to camouflage spatial effects.

Round whitefish frequented the Pickering GS 'A' discharge area over the entire sampling period, but only in low numbers. The catch per unit effort in gill nets ranged from two in May and December to ten in August. Catches of round whitefish at Duffin Creek were only slightly less than those at Pickering GS 'A' discharge, ranging from zero per gill net set in August and November to 11 per gill net set in September.

Figure 3.7-6 shows the catch per unit effort (CUE) of alewife, brown bullhead, smelt and gizzard shad caught by beach seine over the sampling period for each location. Alewife were abundant in beach seines during two separate intervals, one during May and June, when they were found close inshore near Duffin Creek and the Pickering GS 'B' discharge location, and the other during August and September, when they were concentrated at Simcoe Point (August only) and Pickering GS 'A' discharge. The maximum CUE was 399 fish per beach seine obtained at the Pickering GS 'A' discharge during September (Figure 3.7-6).

Beach seine catches of brown bullhead, smelt and gizzard shad were low. Brown bullhead were captured mainly during July, when the maximum CUE was 14 at Pickering GS 'A' discharge, and August, when the greatest CUE (11) occurred at Simcoe Point. For smelt the maximum catch per beach seine was recorded at Simcoe Point (CUE = 83) during August, although a moderate number were caught at the Pickering GS 'B' discharge location in May (CUE = 69), and at Duffin Creek in August (CUE = 54). The only substantial gizzard shad beach seine catch was obtained at the Pickering GS 'B' discharge location in September (CUE = 146) (Figure 3.7-6).

Several species were present in numbers too small to allow calculation of separate catch per unit effort estimates, therefore the seasonal distribution of four such fish species, white perch, yellow perch, white bass and brown trout, is presented for combined gill and trap net data obtained at Pickering GS 'A' and 'B' discharge locations (Figure 3.7-7). The abundance of these four species was negligible at both Duffin Creek and Simcoe Point; thus these locations are not represented in Figure 3.7-7.

White perch were not common at the Pickering GS 'A' discharge area during spring and early summer, but were present in larger numbers from August through December, with 91 fish caught in November. However white perch were sparse in the Pickering GS 'B' discharge location throughout the entire sampling period (Figure 3.7-7).

White bass were also collected at the Pickering GS 'A' discharge from August through December, but the largest number (36) was caught during November. The persistence of white perch and white bass in the Pickering GS 'A' discharge area in late fall and early winter may indicate that these species are attracted to the thermal plume as the ambient lake temperature declines.

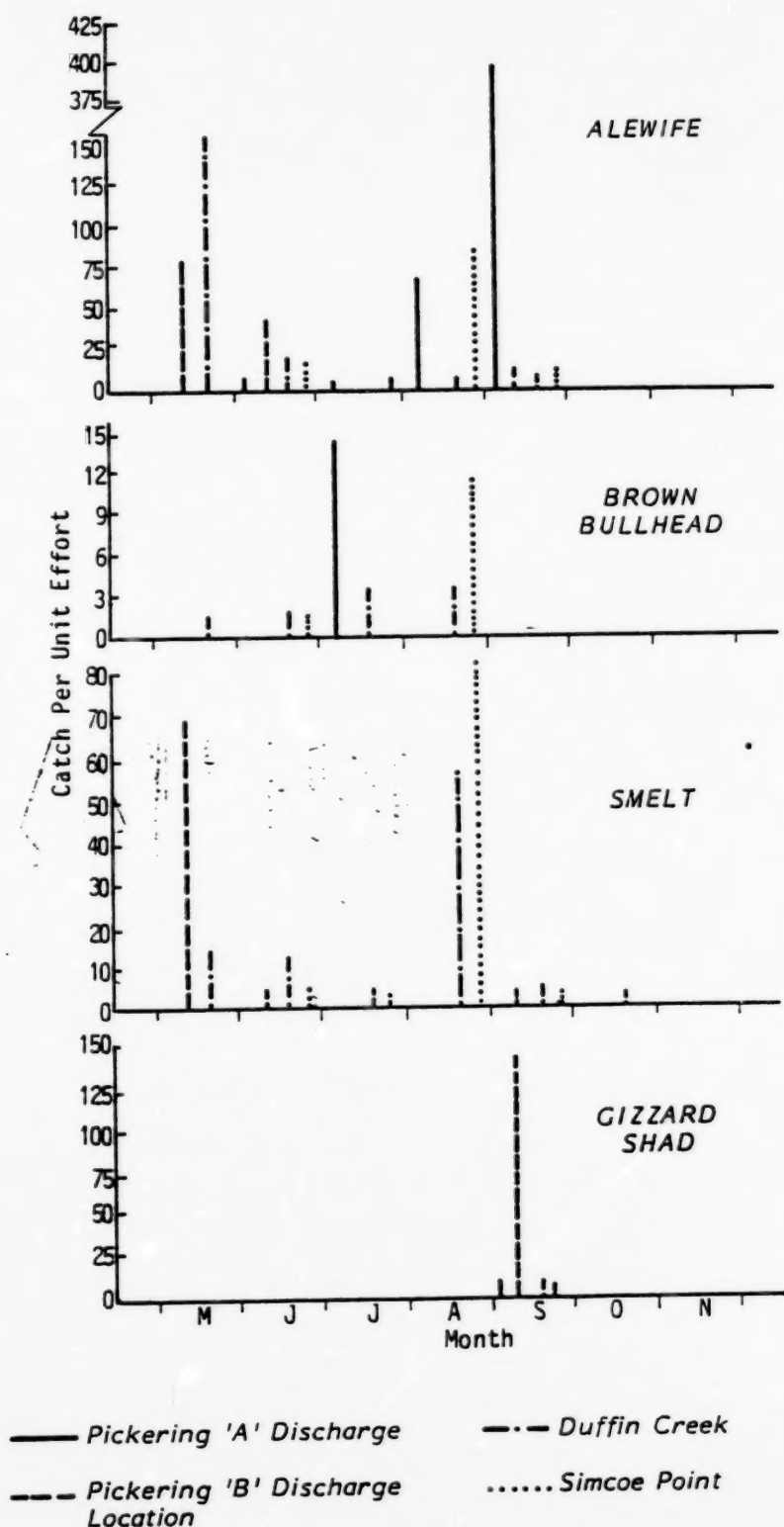


FIGURE 3.7-6
 SEASONAL CATCH PER UNIT EFFORT OF ALEWIFE,
 BROWN BULLHEAD, SMELT AND GIZZARD SHAD
 CAUGHT BY BEACH SEINE - PICKERING GS 'B', 1981
 - 91 -

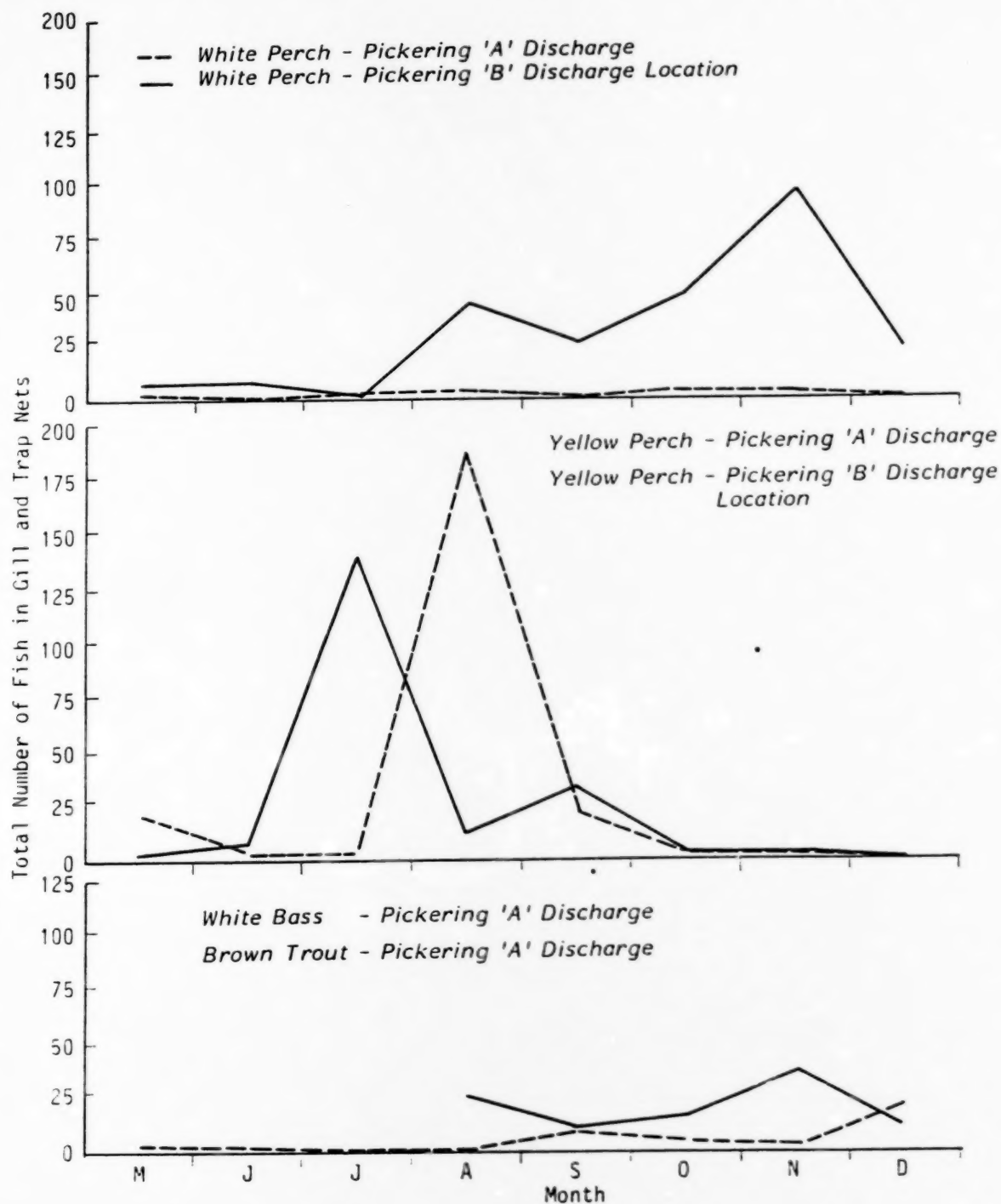


FIGURE 3.7-7

TOTAL MONTHLY CATCH (FOR COMBINED GILL AND TRAP NET DATA) OF WHITE PERCH, YELLOW PERCH, WHITE BASS AND BROWN TROUT IN THE PICKERING GS 'A' AND 'B' DISCHARGE LOCATIONS - PICKERING GS 'B', 1981

The abundance of yellow perch peaked in the Pickering GS 'A' discharge in July and in the Pickering GS 'B' discharge location in August, when 138 and 187 fish were caught, respectively.

There were few brown trout caught at any of the stations sampled, and the largest catch of this salmonid (23) occurred in December at the Pickering GS 'A' discharge.

Fish Impingement

During 1981 a total of 29 000 kg of fish were impinged at Pickering GS 'A' (Ontario Hydro NGD Report No IR-07260-4). Smelt made up 18% of the fish impingement in 1981 and were mainly found impinged in May and June. Alewife impingement, which accounted for 76% of the total impingement, was the highest since 1977. Similarly, the total alewife catch from experimental fishing (all gear types combined) near Pickering GS 'A' discharge from May to December, 1981 was 9 633 fish which is the highest alewife catch in three years (cf Ontario Hydro Research Division Report No 82-266-K and in draft).

Figure 3.7-8 compares the seasonal catch of alewife (all gear types combined) taken during experimental fishing at Pickering GS 'A' discharge with the weight of alewife impinged over the same period. It is clear that the seasonal peak in alewife abundance (June and July) derived from experimental catch data is also reflected in the impingement data. The second smaller peak in alewife abundance during September, which appeared in both catch and impingement records, represents alewife captured in beach seine hauls (Figures 3.7-6 and 3.7-8) which were probably young-of-the-year. Both sets of data show a characteristic decline in alewife abundance from October through December (Figure 3.7-6).

It is noteworthy that 3 kg of whitefish were impinged during January, 1981, constituting the first appearance of the coregonid sub-family in Pickering GS 'A' impingement records (Ontario Hydro RMEP Report No IR-07260-4).

3.8 Winter Waterfowl

Winter waterfowl in the Pickering vicinity were observed on 15 sampling dates from September 25 to April 8. The observed species abundance is presented in Appendix XIV. Approximately 47 000 observations of waterfowl comprised of 24 species and 65 000 observations of gulls were recorded during the survey.

Mallard, *Anas platyrhynchos*, was the most abundant waterfowl species comprising 45.5% of the total waterfowl observed (Table 3.8-1). Canada Goose, *Branta canadensis* (15.1%), Black

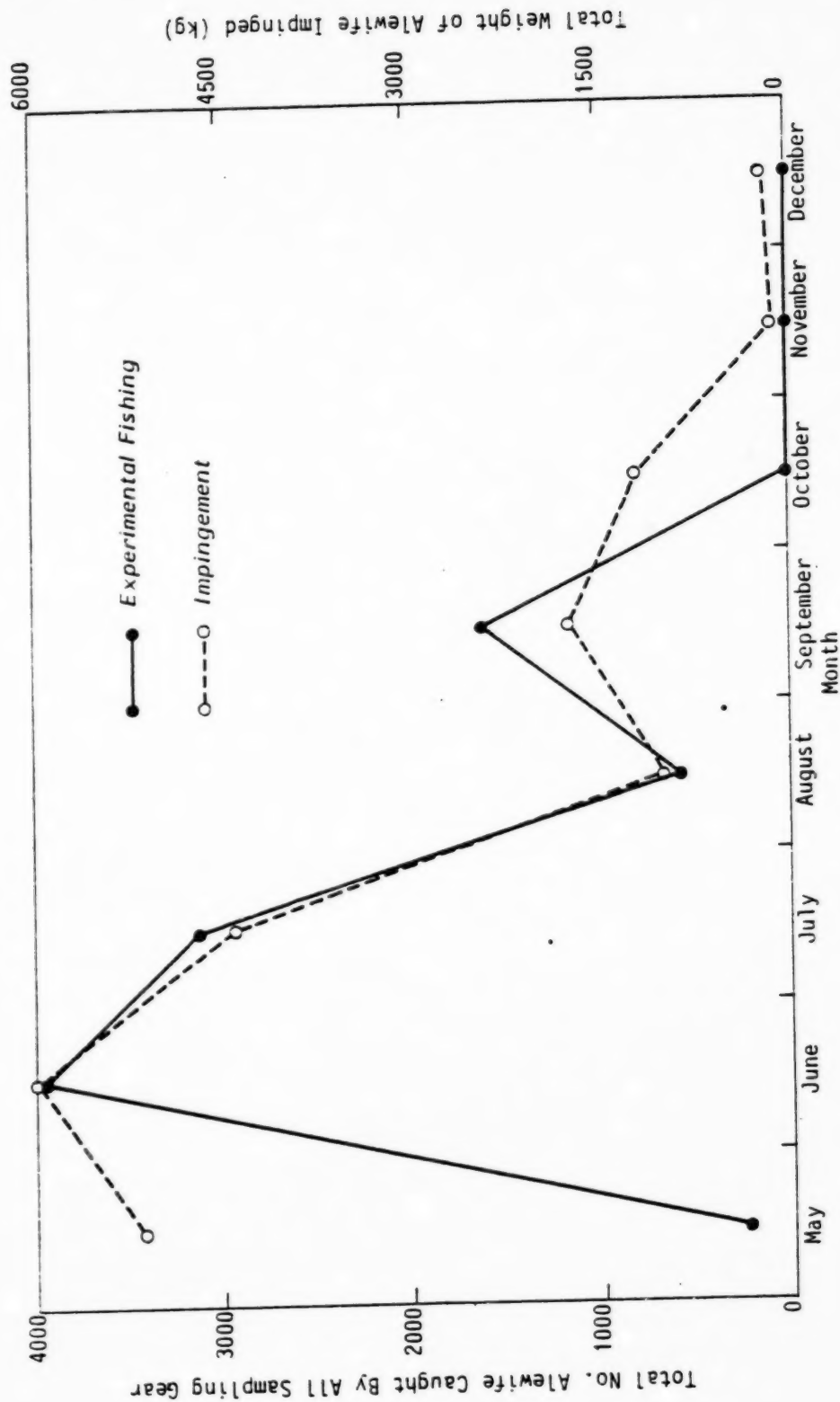


FIGURE 3.7-8
COMPARISON OF ALEWIFE CATCHES MADE DURING EXPERIMENTAL
FISHING AND BY IMPINGEMENT - PICKERING GS'B', 1981

Duck, *Anas rubripes*, (12.9%) and Common Merganser, *Mergus merganser*, (12.2%) were relatively abundant.

Mallard was also the most frequently occurring waterfowl species. Mallards were observed in 23.6% of the observation intervals. Common Goldeneye, *Bucephala clangula* (14.1%), Common Merganser (12.6%), Bufflehead, *Bucephala albeola*, (10.4%) and Canada Goose (10.0%) were frequently recorded in observation intervals.

Waterfowl numbers observed from September 1980 through April 1981 tended to be greater at the Pickering GS sites rather than at the offsite sampling locations (Table 3.8-2). On 5 of the 15 sampling dates the average number of waterfowl observed per 10-min interval was greater at the Pickering GS sites. The greatest number of waterfowl were observed at Pickering GS 'A' (n = 10 461) and the least at Rouge River (n = 3 994) (Table 3.8-3).

TABLE 3.8-1

PER CENT COMPOSITION AND FREQUENCY OF OCCURRENCE
OF MAJOR WATERFOWL SPECIES AT PICKERING, 1981-1982

Species	Number Recorded	%	Number of Intervalst	%
Mallard	21 481	45.5	337	23.6
Canada Goose	7 119	15.1	142	10.0
Black Duck	6 115	12.9	122	8.6
Common Merganser	5 779	12.2	180	12.6
Gadwall	1 531	3.2	40	2.8
Common Goldeneye	1 367	2.9	201	14.1
Scaup sp	1 224	2.6	69	4.8
Unidentified	850	1.8	2	0.2
Bufflehead	712	1.5	148	10.2

† Number of 10 minute intervals in which the species was recorded

Mallards were most abundant or second most abundant waterfowl species observed at each site. Common Merganser was the dominant waterfowl species observed at Ajax (44.7%) while Black Duck was the most abundant waterfowl species recorded at Pickering GS 'B' (35.4%) and the major waterfowl species observed at Frenchman Bay was Canada Goose (48.6%). Gadwall, *Anas strepera*, were only observed at Duffin Creek (10.1%) and Rouge River (18.3%) and were primarily observed within the marsh areas associated with these sites.

TABLE 3.8-2

AVERAGE NUMBER OF WATERFOWL OBSERVED PER 10 MINUTE
INTERVAL AT PICKERING GS AND CONTROL LOCATIONS, 1981-1982

Date	Pickering GS ¹	Non-Station Sites ²
Sept 25	1	10
Oct 9	6	32
Oct 23	6	29
Nov 6	4	36
Nov 20	32	53
Dec 4	13	181
Dec 18	210	42
Jan 5	334	86
Jan 15	929	49
Jan 29	607	45
Feb 15	83	97
Feb 26	149	265
Mar 15	77	199
Mar 26	33	19
Apr 8	20	60
Average All Dates	177	80.2

¹ Pickering 'B', Pickering 'A' Discharge and Intake

² Ajax, Duffin Creek, Frenchman Bay and Rouge River

The waterfowl observation period from September 25 to April 8 was subdivided into 5 observation periods each consisting of 3 observation days as follows:

1. September 25 - October 23
2. November 6 - December 4
3. December 18 - January 15
4. January 29 - February 26
5. March 15 - April 8

Duffin Creek, the Rouge River and their adjacent marshes were ice free in observation periods 1 and 2. The marshes were covered with ice in periods 3 to 5 while Duffin Creek and the Rouge River were ice covered only in periods 3 and 4. All other sampling locations were ice free throughout the 5 study periods.

TABLE 3.8-3
TOTAL NUMBERS OF WATERFOWL RECORDED DURING
10 MINUTE OBSERVATION PERIODS AT PICKERING, 1981-1982

Species ¹	Ajax		Duffin Creek ²		Pickering 'A'		Pickering 'B'		Frenchman Bay		Rouge River ²		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Mallard	2340	26.8	4569	57.4	7471	71.2	2661	29.6	2413	34.0	2027	50.8	21481	45.5
Canada Goose	444	5.1	1263	15.9	1423	13.6	89	1.0	3451	48.6	449	11.2	7119	15.1
Black Duck	1364	15.6	262	3.3	1264	12.1	3183	35.4	32	0.5	10	0.3	6115	13.0
Common Merganser	3899	44.7	421	5.3	259	2.5	730	8.1	165	2.3	305	7.6	5779	12.2
Gadwall	0	0	800	10.1	0	0	0	0	0	0	731	18.3	1531	3.2
Common Goldeneye	174	2.0	408	5.1	59	0.6	614	6.8	24	0.3	88	2.2	1367	2.9
Scaup sp	209	2.4	0	0	0	0	830	9.2	141	2.0	44	1.1	1224	2.6
Bufflehead	192	2.2	0	0.1	27	0.3	413	4.6	33	0.5	39	1.0	712	1.5
All species	8716		7954		10503		8978		7098		3994		47243	

¹ those species which comprised at least 1% of the total birds observed.

² observations from lake and adjacent marshes.

The mean number of dabbling and diving ducks observed per 10 min interval at each sampling location within each of the 5 time periods is presented in Figure 3.8-1. The major concentration of waterfowl, primarily dabbling ducks, was recorded at the Pickering GS 'A' intake within periods 3 and 4 and at the Pickering GS 'B' discharge location in period 3. The waterfowl observed at these sites were predominantly Mallards and Black Ducks. The increase in waterfowl at these sites coincided with the freezing of all observed marshes and water courses. The dabbling ducks recorded at Frenchman Bay during period 4 may be associated with an adjacent unobserved marsh in which an area of approximately 200 sq m remained open throughout the winter months. Waterfowl at this marsh were regularly fed by the public.

The seasonal distribution of the major dabbling and diving ducks at survey locations is presented in Figures 3.8-2 and 3.8-3. Mallard were very abundant at the Pickering GS 'A' intake in period 3 (406) and 4 (370) respectively. They were also relatively abundant at the Pickering GS 'B' discharge (137) in period 3. During the ice free observation period 2, Mallards were most frequently observed at Ajax (100) and Duffin Creek (83).

Black Duck were very abundant at the Pickering GS 'B' discharge location (170) and Pickering GS 'A' intake (100) in period 3. Black Duck observations remained relatively high at Pickering GS 'A' intake (40) in period 4 but declined substantially at Pickering GS 'B' discharge (2).

Gadwall were the predominant waterfowl species observed in the marsh areas at Rouge River (35) and Duffin Creek (52) in periods 1 and 2 respectively. They were not observed at the other observation sites throughout the survey.

Canada Geese were observed relatively frequently during period 4 at Frenchman Bay (145) and Pickering GS 'A' discharge (56). The aggregation of Canada Geese in these areas may be a result of public feeding and open water in the marsh at Liverpool Road.

Common Merganser were very abundant at Ajax (200) in the fourth observation period. All of these birds comprised one flock of 600 birds observed on February 26. Common Mergansers were also relatively abundant at Pickering GS 'B' discharge in periods 4 (17) and 5 (15).

Common Goldeneye were relatively abundant at Duffin Creek (20) and Pickering GS 'B' discharge location (18) during the third observation period. Their observed numbers declined to 1 and 3 birds at each respective site in period 4.

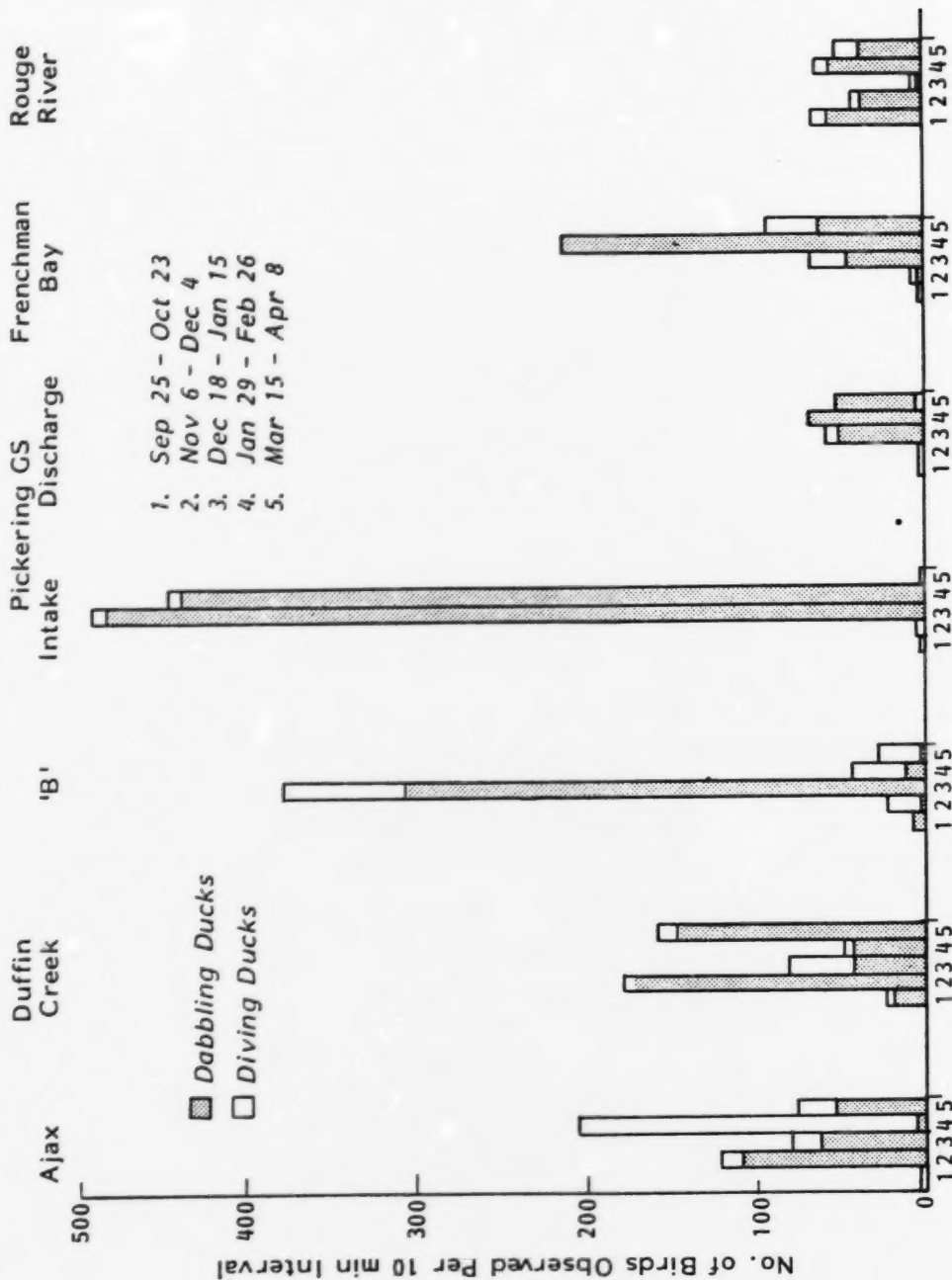


FIGURE 3.8-1
MEAN NUMBER OF WATERFOWL OBSERVED PER 10 MINUTE
INTERVAL PICKERING 1981-1982

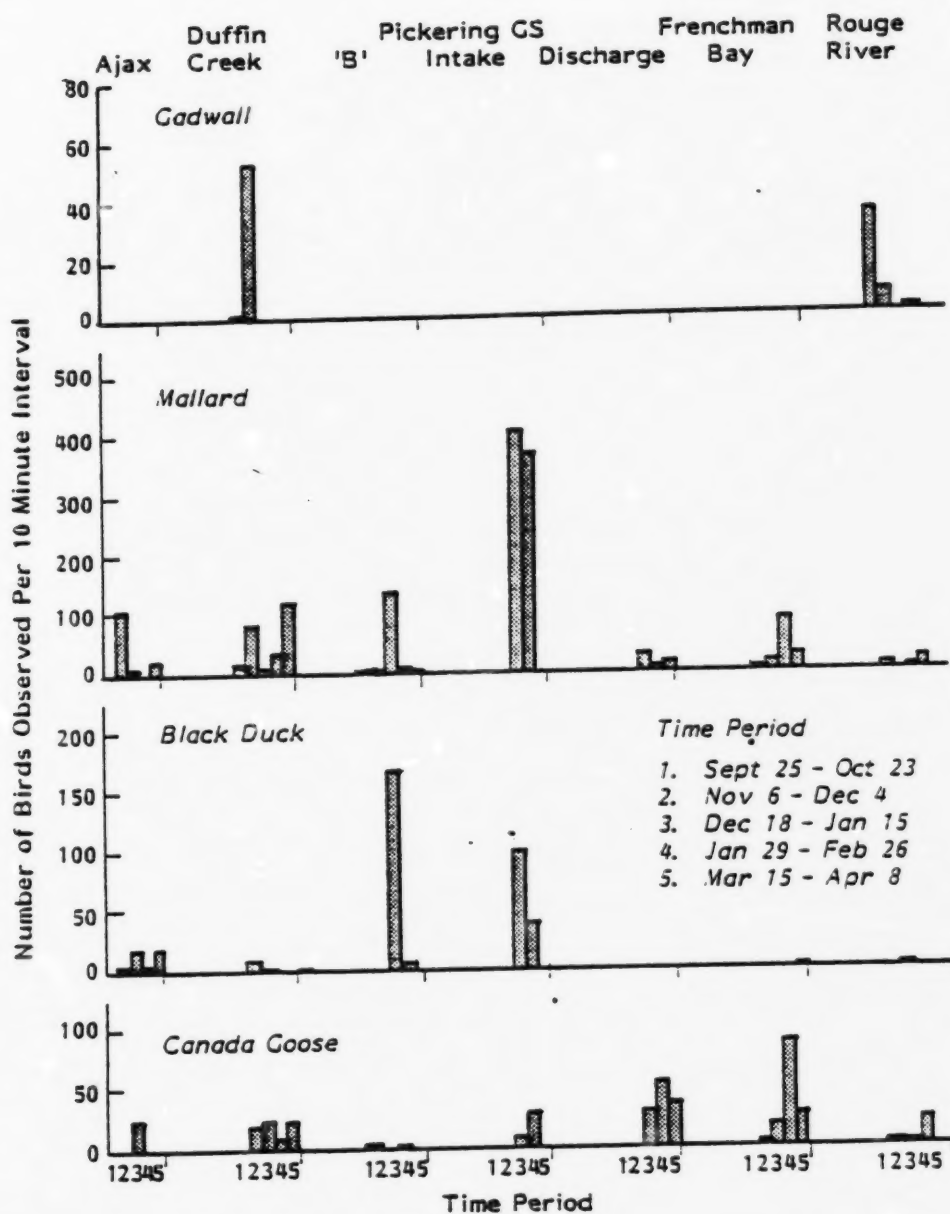


FIGURE 3.8-2
ABUNDANCE (NO. OBSERVED PER 10 MINUTE INTERVAL)
OF THE MAJOR DABBLING DUCK (INCLUDING GEESE)
SPECIES, PICKERING 1981-1982

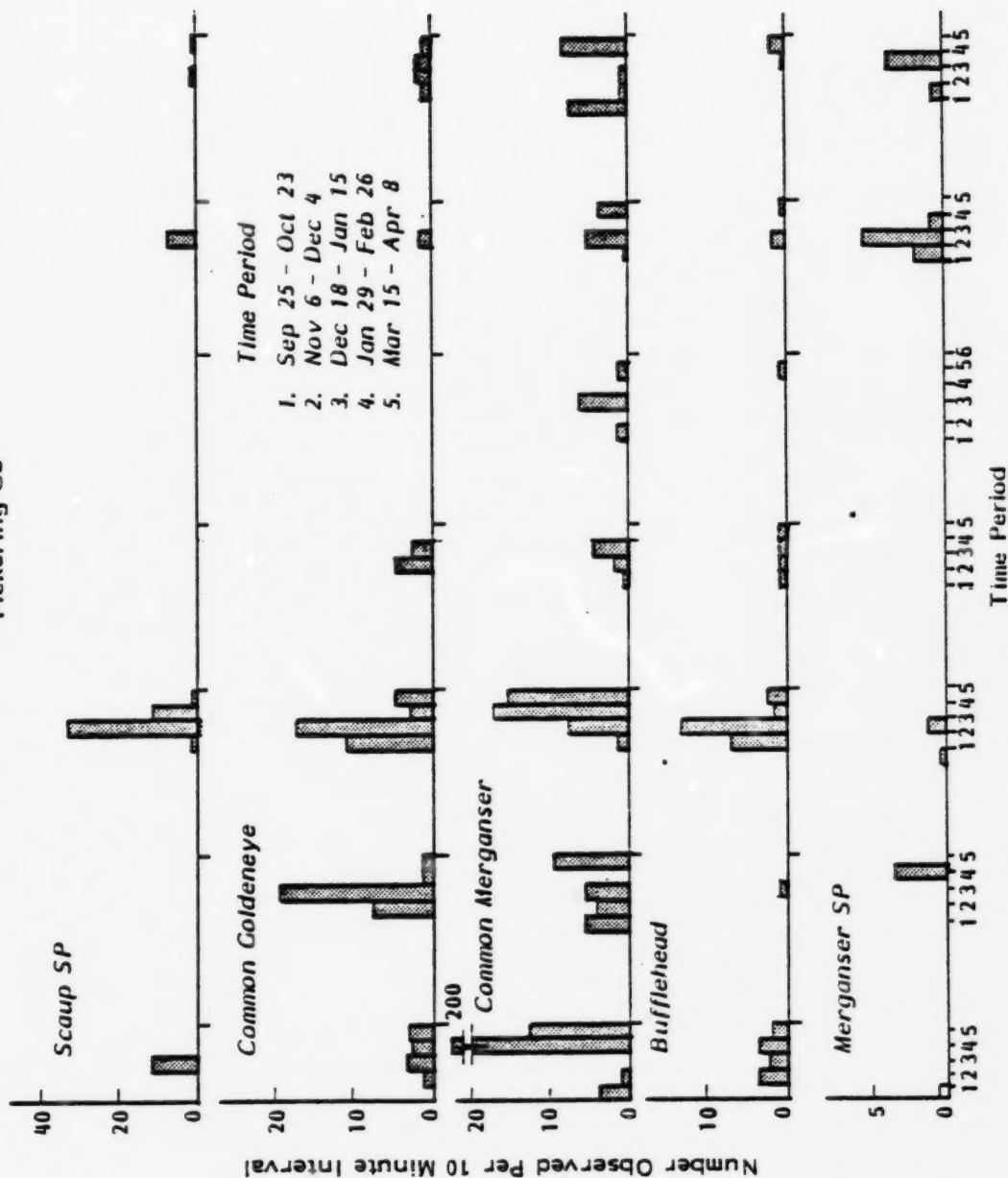


FIGURE 3.8-3
ABUNDANCE (NO. OBSERVED PER 10-MINUTE INTERVAL)
OF THE MAJOR DIVING DUCK SPECIES PICKERING 1981-1982

The greatest numbers of Scaup sp (33) and Bufflehead were recorded at Pickering GS 'B' discharge during observation period 3. Both species were relatively uncommon at all sites during all other observation periods.

Waterfowl distribution when the marshes were ice covered (December 18, 1981 to April 8, 1982) and ice free (September 25, 1981 to December 4, 1981) was statistically analyzed (Mann-Whitney U-test) (Table 3.8-4). Waterfowl numbers increased significantly ($p < 0.01$) from 7 to 175 birds per 10 min interval at the station sites during the ice covered period. Mallard, Common Merganser, Common Goldeneye ($p < 0.01$) and Black Duck ($p < 0.05$) species exhibited this pattern.

A significant decrease ($p < 0.01$) in Gadwall numbers from 10 to 0 birds per 10 min interval at non-station sites occurred on or before marsh areas froze over. A similar pattern was evident for other migrating species composed primarily of American Widgeon, *Anas americana*, Wood Duck, *Aix sponsa*, and Ring-necked Duck, *Anthya collaris*.

Significant preferences for station sites during the ice present period (December 18, 1981 to April 8, 1982) were exhibited by Black Duck ($p < 0.01$), Scaup sp and Bufflehead ($p < 0.05$). Common Merganser displayed a significant preference for non-station sites ($p < 0.05$) during the ice covered period. The majority of these birds (3600) were observed at Ajax on February 26.

Mallards and Gadwall exhibited significant preferences ($p < 0.01$ and < 0.05 respectively) for non-station sites before marsh freeze up. The majority of these birds utilized the marsh areas in the ice-free period.

The study results are similar to the 1979-1980 waterfowl survey (OHRD Report 82-266-K and Haymes and Sheehan 1982). Dabbling duck distribution appeared to be dependent upon ice formation in the marshes. During the ice-free period high concentrations of dabbling ducks were recorded in the marsh areas with relatively low densities on the lake. The high density of dabbling ducks recorded at Simcoe Point (November 6 to December 4) is related to Mallards and Black Ducks feeding in a cut corn field near Simcoe Point. After freeze up the majority of dabbling ducks were located around the generating stations in the discharge plume and protected intake area. Mallards and Black Ducks continued to feed in the corn fields at Simcoe Point during the December 18 to January 15 period. High densities of dabbling ducks were recorded near Frenchman Bay where the ducks were fed and a small portion of the marsh remained ice free. As soon as the Rouge River Marsh started to open up the dabbling duck densities increased.

TABLE 3.8-4

NUMBERS (TOTAL AND AVERAGE PER 10-MIN INTERVAL) OF THE MOST ABUNDANT WATERFOWL SPECIES OBSERVED AT THE PICKERING NUCLEAR GENERATING STATION AND AT NON-STATION LOCATIONS WITH RESPECT TO THE PRESENCE OF ICE IN THE MARSHES

	Ice Present a				Ice Absent b				All Dates	
	Station		Non-Station		Station		Non-Station		All Locations	
	Total	#/Interval (n = 108)	Total	#/Interval (n = 216)	Total	#/Interval (n = 72)	Total	#/Interval (n = 144)	Total	#/Interval (n = 540)
Mallard	10093	93 ^e	7218	33	39	<1 ^{ce}	4131	29 ^c	21481	40
Canada Goose	1428	13	5318	25	84	1 ^f	289	2	7119	13
Black Duck	4377	41 ^{cf}	1324	6 ^c	70	1 ^f	344	2	6115	12
Common Merganser	958	9 ^{de}	4414	20 ^d	31	<1 ^e	376	3	5779	11
Gadwall	0	0	24	0 ^e	0	0 ^d	1507	10 ^{de}	1531	3
Common Goldeneye	510	5 ^e	648	3	163	2 ^e	46	<1	1367	3
Scaup sp.	820	8 ^d	392	2 ^d	10	<1	2	<1	1224	2
Bufflehead	334	3 ^d	210	1 ^d	106	1	62	<1	712	1
Other Species	384	4	1046	5 ^e	32	<1	453	3 ^e	1915	4
All Species	18904	175 ^{ce}	20594	95 ^c	535	8 ^{de}	7210	51 ^d	47243	87

a December 18, 1981 - April 8, 1982

b September 25 - December 4, 1981

c Significant difference Station vs non Stations ($p < 0.01$ Mann - Whitney U-test)

d Significant difference station vs non-station ($p < 0.05$)

e Significant difference, ice present vs ice absent ($p < 0.01$)

f Significant difference, ice present vs ice absent ($p < 0.05$)

Diving duck densities were relatively low in the Pickering vicinity during the ice free period. With the complete freezing of more northern lakes in December, diver densities increased in the study area during the ice covered period. Diving duck densities were high near the generating station in December and January. These birds were located primarily in the area influenced by the discharge plume. Medium densities of divers were located near the generating stations in February and March. During spring migration, medium densities of diving ducks were recorded along the entire study area.

Larids observed in the Pickering vicinity were composed primarily of Ring-billed (*Larus delawarensis*) and Herring (*L. argentatus*) Gulls. The majority of these birds (2034) were recorded at Frenchman Bay in the fourth time period (Figure 3.8-4). Relatively high gull concentrations were recorded at Rouge River and Frenchman Bay in the fifth time period. Gulls in the Frenchman Bay Area were mainly found at and to the west of the mouth of Frenchman Bay.

4.0 SUMMARY

4.1 Physical Characteristics

Largest amounts of sediment were collected in traps set at the nearshore locations (3 m) with quantities generally diminishing with increased depth. The sedimentation rate in the study area was highest along Transect K, 1.0 km east of the Pickering GS 'B' discharge location. Fall sedimentation rates were higher than those estimated for the summer. The per cent loss on ignition, as an indication of organic content of the sediment samples, decreased with increasing spar depth.

Thermal stratification of the water column was not apparent on the days that monthly temperature profiles were recorded. Dissolved oxygen levels in the water column, monitored monthly between May and December, were at or above saturation levels.

Mean daily temperatures recorded at the 3 m depth at the Pickering GS 'B' discharge location show that gradual warming of the water occurred between mid March and late June, followed by rapid warming into the first week of August. Maximum mean daily temperature at this location was 21.2°C (August 22) while at the 3 m depth in the Pickering GS 'A' discharge it was 31°C (September 2). Major upwellings occurred several times between May and October.

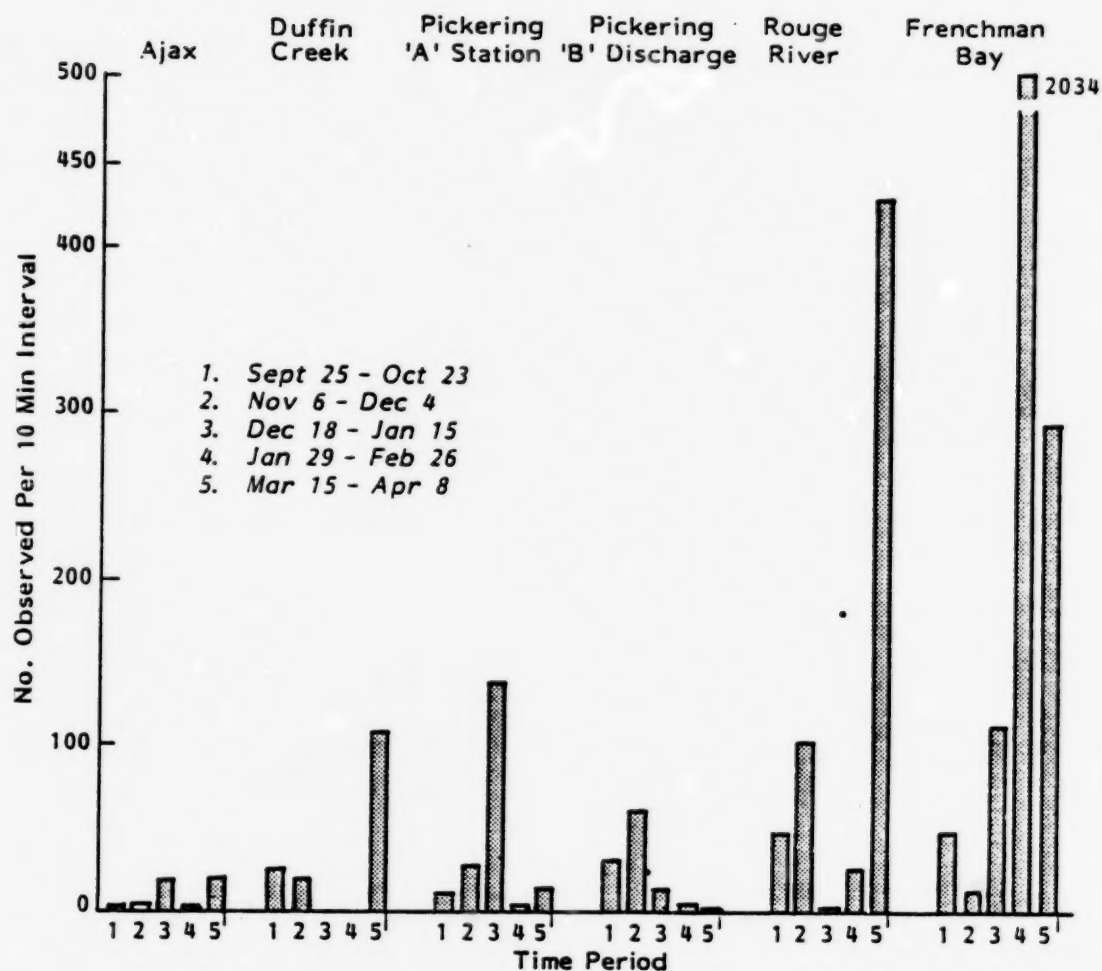


FIGURE 3.8-4

NUMBER NON-FLYING GULLS OBSERVED PER
10-MINUTE INTERVAL PICKERING 1981-1982

4.2 Water and Sediment Quality

No consistent spatial trends were obvious in the levels of the water chemistry parameters monitored although some seasonal differences were observed. Turbidity and levels of suspended solids were higher in May and November than on the two summer dates.

The water in the study area was moderately basic. November levels of phosphorous were equal to or slightly in excess of the MOE objective for the avoidance of nuisance concentrations of algae. However, low temperatures encountered at this time precluded rapid growth of algae. Ammonia levels were typical of unpolluted waters, while levels of organic nitrogen were indicative of eutrophic conditions in May, and of oligo-mesotrophic conditions on the remaining sampling dates. Silica levels were low and chlorophyll a levels were below the range considered to be mesotrophic.

Phenols, not found in detectable levels ($<4.0 \mu\text{g/L}$) in 1979, were found in concentrations of up to $8 \mu\text{g/L}$.

Iron, copper, arsenic, selenium and nickel were the only metals found in levels at or above their respective detection limits. Of these, only copper was found in levels in excess of the MOE objectives for the protection of aquatic life.

Of the surficial sediment components analyzed, iron was the main constituent identified followed by Manganese.

4.3 Attached Algae

All suitable substrate at the sampling spars was covered by attached algae in August and October, but not in July. No algal growth was found along Transect E on any of the sampling periods and was attributed to the lack of suitable substrate along this transect. No distinct seasonal trends were apparent.

4.4 Phytoplankton

In terms of biomass, the diatoms were the main phytoplankton group present on May 21, while the flagellates dominated on August 6 and November 28. *Cryptomonas* was the most important taxa present on all three sampling dates. Total phytoplankton biomass was lowest on May 21 (76 mg/m^3) and highest on August 6 (2378 mg/m^3). With the strong currents encountered in the

vicinity of the stations it was considered unlikely that phytoplankton densities could be related to the development of the thermal plume since they would be rapidly transported out of the immediate discharge area. However, the higher densities frequently observed around the stations may be indicative of some influence of the stations on the phytoplankton.

4.5 Zooplankton

The rotifers outnumbered the crustacean zooplankton on all three sampling dates. On May 21, *Asplanchna* was the main rotifer present while the crustacean numbers consisted mainly of cyclopoid nauplii largely belonging to the species *Diacuclous bicuspidatus thomasi*. On August 6, *Polyarthra* was the most abundant rotifer while the cyclopoid nauplii (mainly *D. bicuspidatus thomasi* nauplii) again made up the largest portion of the crustacean numbers. *Polyarthra* was again the dominant rotifer present on October 5 and the cladoceran *Dosmina longirostris* was the most abundant crustacean zooplankton. Highest rotifer and crustacean numbers (58 273 and 39 892 m³, respectively) were estimated on August 6. As was found with the phytoplankton, zooplankton densities could not be directly related to the distribution of the thermal plume due to strong currents rapidly transporting them out of the immediate discharge area. However, higher densities frequently found around the stations may be indicative of some influence of the stations on the zooplankton. Higher densities frequently found around Duffin Creek appeared to indicate an influence of the Duffin Creek effluent.

4.6 Zoobenthos

The most common taxa occurring at Pickering GS 'B' were oligochaete worms, midges (Diptera: Chironomidae), and amphipods. Total benthic density decreased over the period sampled (July to October). Density and species richness were generally highest at the 7 to 12 m depth, in contrast to diversity, which was maximal at the 3 m depth. Density and dominance (per cent abundance) for Oligochaeta and Chironomidae decreased over the study period. Amphipoda reached maximum density in August, but maximum dominance in October, due to the sharp decline in oligochaete numbers.

Diversity was generally lowest along the Pickering GS 'A' discharge transect, except at the 1 m depth where diversity values were higher than the mean for all transects. Faunal assemblage distribution was determined by seasonal trends, depth, substrate composition and algal cover. Temperature effects were not detectable.

4.7 Fish

Alewife larvae and eggs predominated in paired surface hauls collected along six sampling transects. Other larvae caught included smelt, carp, gizzard shad and a single round whitefish larva. Highest densities of smelt and alewife larvae occurred on May 19 and July 8, respectively.

The juvenile and adult fish collections were numerically dominated by alewife, followed by brown bullhead, smelt and white sucker. The number of taxa ranged from 27 to 31 at the four transects sampled. Large numbers of alewife were found near the Pickering GS 'A' discharge over the sampling season. Several common littoral fish species such as pumpkinseed, white bass and white perch showed greater abundance at the Pickering GS 'A' discharge than at other locations sampled.

Fish impingement records demonstrated that alewife continues to be the primary fish species impinged, and that a small quantity of whitefish was impinged for the first time.

4.8 Winter Waterfowl

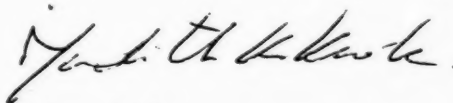
Waterfowl concentrations in the vicinity of the generating station increased after marshes and more northern lakes froze in December. Maximum densities of dabbling and diving ducks were recorded at the station sites after freeze up. Mallard, Canada Goose, Black Duck and Common Merganser were the major waterfowl species observed.

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ANALYTICAL TECHNIQUES USED IN THE ANALYSIS OF WATER CHEMISTRY VARIABLES
ANALYTICAL SERVICES SECTION, CHEMICAL RESEARCH DEPARTMENT, ONTARIO HYDRO RESEARCH DIVISION

ANALYTE	COLLECTION PRESERVATION	SAMPLE TREATMENT	TECHNIQUE/INSTRUMENT	REFERENCE
pH Sp Cond		Holding to 25°C	Fisher Accumet Meter using Combination Electrode Radiometer Conductivity Meter CPM (1 cm cell) CUC104	Standard Methods 421 Standard Methods 205
Alkalinity			636 Metrohm Auto Tester - Inflection Point	UNHD 81-149
Turbidity	Unfiltered LPE Bottle	filter thru 0.45 µm filter	Nach 2100A Turbidimeter Gravimetry	Standard Methods 214 Standard Methods 209
Susp Solids Colour	Cool 4°C	filtered thru 0.22 µm millipore	Gravimetry Ion Chromatography Dionex Model 12	Standard Methods 209 UNHD 81-210, 78-159
NH ₃ , SO ₄		Unfiltered	Colorimetry Colorimetry Beckman 900 - TOC Analyzer	Standard Methods 424 UNHD No 79-124-K
Total NO ₃ , Total SiO ₂ , TIC		Unfiltered	Combustion Infrared Calculation	Standard Methods 505
Hardness	see Ca, Mg	Unfiltered		Standard Methods 114A
Mn, TMN	Unfiltered 1 ml/L H ₂ O ₂	filtered Preliminary Acid Digestion and Distillation	Colorimetry, Automated - Technicon Auto Analyzer II	Standard Methods 420A UNHD 80-414
Calcium Magnesium Sodium Potassium Iron Manganese Zinc	Unfiltered LPE Bottle 5 ml/L Vitrox (HM)	HCl addition	Flame Atomic Absorption Spectrophotometry Model IL 751	UNHD 79-114-K
Aluminum Copper Nickel		H ₂ O ₂ addition	Atomic Absorption Spectrophotometry Model IL 951 (graphite furnace)	UNHD 82-128-K
Arsenic Selenium		Preliminary Acid Digestion	Hydride Formation - Flamacon Atomic Absorption Spectrophotometry	UNHD 82-128-K
Mercury	Filtered thru 0.45 µm Filter % ml/l 1. HM; + 10 ml/L Gold III		Automated Vapour Generation - Atomic Absorption Spectrophotometry	Report Pending

^a NOTE: In the reference, "Standard Methods" refers to the Monograph "Standard Methods for Examination of Water and Wastewater", 17th edition, 1980, APWA/APHA/NFCE, USA.

[illegible]

APPENDIX II

MEAN AND STANDARD DEVIATION OF DOMINANT PHYTOPLANKTON DENSITIES
AND TOTAL PHYTOPLANKTON BIOMASS AT PICKERING GS 'B'
- 1981 (From 3 samples collected by 3-m tube)

Date	Dominant taxa	$\bar{X}$	SD
May 21, 1981	<i>Cryptomonas</i> sp	213	33.5
	<i>Melosira granulata</i>	225	128.5
	Total Biomass	852.3	141.8
August 6, 1981	<i>Cryptomonas</i> sp	2971.0	563.9
	Total Biomass	3248.6	619.1
November 25, 1981	<i>Cryptomonas</i> sp	894.1	276.5
	<i>Tabellaria fenestrata</i>	266.7	151.2
	Total Biomass	1479.5	460.4

APPENDIX III

Mean and Standard Deviation of Dominant Rotifer and
Crustacean Zooplankton present in Replicate Samples taken
at the 0. km Location on Transect K, Lake Ontario
At Pickering GS 'B',

Date	Taxa	Mean	Standard Deviation
May	<u>Brachionus angularis</u>	648.0	211.8
	<u>Asplanchna</u> spp	57996.7	20073.5
	Cyclopoid copepod nauplii	3658.7	244.3
	Calanoid copepod nauplii	740.0	111.0
August	<u>Polyarthra</u> spp	2116.7	2167.7
	<u>Keratella cochlearis</u>	1296.0	112.1
	<u>Keratella carlinae</u>	1037.0	231.1
	<u>Kellicottia longispina</u>	1217.3	339.5
	Cyclopoid copepod nauplii	851.3	273.9
	Calanoid copepod nauplii	779.7	244.7
	<u>Bosmina longirostris</u>	438.3	134.2
	<u>Diacyclops Liaspidatus thomasi</u> (adults)	438.3	134.2
October	<u>Polyarthra</u> spp	68.0	28.5
	<u>Keratella cochlearis</u>	86.7	38.6
	<u>Bosmina longinestrus</u>	3204.3	827.9
	<u>Diacyclops bicuspidatus thomasi</u>	18.7	18.5

APPENDIX IV

SEDIMENTATION RATES - MEAN mg/cm²/DAY
PICKERING GS 'B' - 1981

May 8 - August 12

Transect	3 m		7 m		12 m	
	Dry Weight	Loss on Ignition	Dry Weight	Loss on Ignition	Dry Weight	Loss on Ignition
E $\bar{x}$	7.30	0.26	2.20	0.18	2.10	0.20
SD	1.70	0.14	0.47	0.04	0.08	0.02
G $\bar{x}$	7.60	0.50	8.30	0.39	4.80	0.40
SD	0.24	0.23	1.28	0.07	0.20	0.02
I $\bar{x}$	No Sample		4.50	0.30	2.30	0.23
SD			0.33	0.04	0.12	0.02
K $\bar{x}$	29.50	0.10	5.00	0.31	4.00	0.36
SD	4.10	0.08	0.20	0.02	0.02	0.0003
M $\bar{x}$	15.70	0.83	3.60	0.32	5.60	0.44
SD	1.30	0.06	0.13	0.05	0.16	0.01
O $\bar{x}$	23.00	0.90	7.30	0.49	3.00	0.30
SD	2.30	0.10	0.03	0.02	0.30	0.01

August 14 - November 4

Transect	3 m		7 m		12 m	
	Dry Weight	Loss on Ignition	Dry Weight	Loss on Ignition	Dry Weight	Loss on Ignition
E $\bar{x}$	19.64	1.02	10.45	*	5.86	0.48
SD	2.37	0.13	2.05	0.06	0.75	0.03
G $\bar{x}$	25.27	0.84	16.68	0.80	6.99	0.54
SD	1.23	0.13	4.64	0.25	0.57	0.04
I $\bar{x}$	45.38	0.68	7.88	0.56	4.30	0.36
SD	6.98	0.13	0.74	0.07	1.15	0.09
K $\bar{x}$	23.03	0.53	12.84	0.89	9.52	0.74
SD	3.00	0.09	2.79	0.23	0.26	0.02
M $\bar{x}$	28.19	0.55	9.97	0.67	11.30	0.88
SD	6.47	0.20	3.15	0.19	1.03	0.07
O $\bar{x}$	No Sample		10.45	0.73	4.93	0.46
SD			2.59	0.11	0.65	0.05

APPENDIX V

Pickering GS 'B'
Water Transparency Readings in metres (m)
May - November 1981

Transect Date	E	G	R	K	M	S
May 31	4.4	3.4	4.5	4.4	4.5	4.2
June 30	3.2	3.3	3.5	3.5	2.5	3.0
July 29	0.5	0.7	1.5	1.4	1.2	2.5
August 21	2.0	3.3	2.6	3.6	3.4	2.9
September 30	4.1	4.1	4.0	4.0	4.2	3.7
October 30	1.3	3.8	4.0	3.2	3.2	4.0
November 17	4.0	5.0	4.9	5.2	5.5	4.5

APPENDIX V (cont'd)

Pickering GS 'B'
Temperature (°C) and Dissolved Oxygen Profiles (PPM),
and Water Transparency Readings (m)
May - December 1981

JUNE 31													
Surface	E	G	R	K	M	S	Surface	E	G	R	K	M	S
1	9.6	7.0	7.0	6.8	6.6	6.8	1	13.0	12.0	10.5	10.7	11.5	11.0
2	7.4	6.6	7.0	6.7	6.5	6.5	2	10.0	10.5	10.0	10.0	11.0	11.0
3	6.5	6.5	6.8	6.6	6.1	6.4	3	8.5	9.5	9.7	9.5	10.6	11.0
4	6.5	6.2	6.7	6.5	6.0	6.1	4	7.2	8.0	9.2	9.0	10.0	10.5
5	6.6	6.2	6.7	6.5	5.8	6.0	5	6.7	7.0	8.2	8.5	9.0	10.0
6	6.2	6.0	6.6	6.4	5.6	5.9	6	6.7	6.7	6.8	7.8	8.5	9.5
7	6.1	6.0	6.5	6.2	5.4	5.9	7	6.5	6.2	6.5	7.2	8.0	9.0
8	6.0	6.0	6.5	6.0	5.4	5.6	8	6.5	6.2	6.2	7.0	7.5	8.5
9	5.7	6.0	6.5	6.0	5.1	5.5	9	6.2	6.2	6.2	6.5	7.0	7.8
10	5.5	5.6	6.0	6.0	5.0	5.6	10	6.0	6.0	6.0	6.0	6.0	6.7
11	5.2	5.1	5.9	6.0	5.1	5.4	11	6.0	6.0	6.0	6.0	6.0	6.5
12	5.1	4.6	5.1	5.8	5.0	5.2	12	6.0	6.0	5.8	6.0	6.0	6.5
13	5.0	4.5	5.1	5.7	5.0	5.0	13	6.0	6.0	5.5	6.0	5.8	6.5
14	4.9	4.5	5.2	5.5	5.0	5.0	14	6.0	6.0	5.5	6.0	5.8	6.5
15	5.2	4.5	5.1	5.5	5.0	4.9	15	6.0	6.0	5.5	6.0	5.5	6.5
MEAN TEMP	6.4	5.8	6.3	6.3	5.6	5.8	MEAN TEMP	7.6	7.6	7.4	8.2	8.1	8.7
MAX & T'S	6.6	1.5	3.0	3.0	2.4	2.6	MAX & T'S	8.5	7.0	5.5	5.3	6.0	4.5

JULY 29													
Surface	E	G	R	K	M	S	Surface	E	G	R	K	M	S
1	20.5	20.7	19.0	19.0	19.0	19.3	1	20.5	20.7	19.0	19.0	19.0	19.0
2	19.5	19.4	18.9	18.9	19.0	19.5	2	19.5	19.4	18.9	18.9	19.0	19.5
3	18.8	19.5	19.4	19.4	19.4	19.1	3	19.5	19.0	19.1	19.0	19.0	19.0
4	19.2	19.5	19.5	19.5	19.4	18.9	4	19.2	19.0	19.0	18.9	18.9	19.1
5	19.5	19.4	19.4	18.5	19.0	18.0	5	19.3	19.0	19.1	19.0	18.9	19.1
6	19.3	19.0	19.2	18.8	19.0	19.0	6	19.3	19.0	18.8	19.0	19.0	19.0
7	19.0	18.9	19.1	18.7	18.4	19.0	7	19.2	18.9	18.9	19.0	19.0	19.0
8	18.5	18.5	18.5	18.5	18.4	19.2	8	19.0	19.0	19.1	19.0	19.0	19.0
9	18.0	17.5	18.0	17.8	19.0	18.6	9	19.2	18.9	19.0	19.0	18.8	18.8
10	17.0	15.2	17.5	17.9	19.0	18.5	10	19.2	18.9	18.9	19.0	18.7	18.8
11	15.7	14.5	16.0	17.6	18.5	17.5	11	19.2	18.8	18.8	18.9	18.5	18.7
12	15.0	14.0	15.4	18.2	17.5	16.1	12	19.0	18.9	18.6	18.6	18.5	18.5
13	13.9	13.5	16.0	17.4	18.2	15.4	13	19.0	18.8	18.5	18.8	18.3	19.0
14	14.0	11.4	16.2	16.5	18.0	15.5	14	18.5	18.7	18.4	18.7	18.0	18.7
15	16.0	13.0	16.1	16.4	17.5	15.0	15	18.0	18.7	18.4	18.5	17.7	18.7
MEAN TEMP	18.1	17.2	18.1	18.1	18.8	17.6	MEAN TEMP	19.2	19.0	18.8	18.9	18.7	18.9
MAX & T'S	10.1	8.5	4.6	3.6	2.5	2.5	MAX & T'S	2.5	1.1	0.7	0.5	1.6	0.8

AUGUST 21													
Surface	E	G	R	K	M	S	Surface	E	G	R	K	M	S
1	22.5	19.0	20.2	20.0	20.4	19.5	1	22.5	19.0	20.2	20.0	20.4	19.5
2	18.4	19.2	19.8	19.1	19.5	18.4	2	18.4	19.2	19.8	19.1	19.5	18.4
3	18.8	19.5	19.4	19.4	19.4	19.1	3	18.8	19.5	19.4	19.4	19.4	19.1
4	19.2	19.5	19.5	19.5	19.4	19.0	4	19.2	19.5	19.5	19.5	19.4	19.0
5	19.5	19.4	19.4	18.5	19.0	18.0	5	19.5	19.4	19.4	18.5	19.0	18.0
6	19.3	19.0	19.2	18.8	19.0	18.5	6	19.3	19.0	19.2	18.8	19.0	18.5
7	19.0	18.9	19.1	18.7	18.4	19.0	7	19.0	18.9	19.1	18.7	18.4	19.0
8	18.5	18.5	18.5	18.5	18.4	19.2	8	18.5	18.5	18.5	18.5	18.4	19.2
9	18.0	17.5	18.0	17.8	19.0	18.6	9	18.0	17.5	18.0	17.8	19.0	18.6
10	17.0	15.2	17.5	17.9	19.0	18.5	10	17.0	15.2	17.5	17.9	19.0	18.5
11	15.7	14.5	16.0	17.6	18.5	17.5	11	15.7	14.5	16.0	17.6	18.5	17.5
12	15.0	14.0	15.4	18.2	17.5	16.1	12	15.0	14.0	15.4	18.2	17.5	16.1
13	13.9	13.5	16.0	17.4	18.2	15.4	13	13.9	13.5	16.0	17.4	18.2	15.4
14	14.0	11.4	16.2	16.5	18.0	15.5	14	14.0	11.4	16.2	16.5	18.0	15.5
15	16.0	13.0	16.1	16.4	17.5	15.0	15	16.0	13.0	16.1	16.4	17.5	15.0
MEAN TEMP	18.1	17.2	18.1	18.1	18.8	17.6	MEAN TEMP	18.1	17.2	18.1	18.1	18.8	17.6
MAX & T'S	10.1	8.5	4.6	3.6	2.5	2.5	MAX & T'S	10.1	8.5	4.6	3.6	2.5	2.5

SEPTEMBER 10													
Surface	E	G	R	K	M	S	Surface	E	G	R	K	M	S
1	6.5	5.9	5.6	5.5	5.1	5.5	1	8.2	7.4	5.5	5.4	5.5	5.5
2	6.5	5.9	5.6	5.5	4.5	5.8	2	8.0	7.4	5.5	5.4	5.5	5.5
3	6.2	5.9	5.6	5.5	5.0	5.8	3	7.7	7.0	5.5	5.4	5.5	5.5
4	6.2	5.8	5.5	5.5	5.0	5.8	4	7.0	6.0	5.5	5.1	5.5	5.5
5	6.0	5.8	5.5	5.5	5.0	5.8	5	6.8	5.9	5.5	5.1	5.5	5.5
6	6.0	5.8	5.5	5.5	5.0	5.8	6	6.2	5.7	5.5	5.1	5.5	5.5
7	6.0	5.8	5.5	5.5	5.0	5.8	7	5.8	5.7	5.5	5.1	5.4	5.5
8	6.0	5.9	5.2	4.5	4.7	5.5	8	5.5	5.6	5.5	5.1	5.4	5.5
9	5.9	5.6	5.0	4.5	4.7	5.4	9	5.4	5.6	5.5	5.1	5.4	5.5
10	5.9	5.6	5.0	4.6	4.7	5.2	10	5.4	5.6	5.5	5.1	5.4	5.5
11	5.9	5.5	4.5	4.6	4.5	5.1	11	5.4	5.6	5.5	5.1	5.3	5.5
12	5.6	5.5	4.4	4.5	4.5	5.1	12	5.4	5.6	5.5	5.1	5.4	5.5
13	5.5	5.5	4.4	4.4	4.5	5.1	13	5.4	5.6	5.5	5.1	5.4	5.5
14	5.5	5.0	4.4	4.4	4.5	5.0	14	5.4	5.5	5.5	5.1	5.4	5.5
15	5.0	4.8	4.2	4.2	4.5	5.0	15	5.4	5.5	5.5	5.1	5.4	5.5
MEAN TEMP	5.9	5.6	5.0	4.8	4.8	5.5	MEAN TEMP	6.1	6.0	5.5	5.3	5.4	5.5
MAX & T'S	1.5	1.1	1.4	1.1	1.1	1.0	MAX & T'S	2.8	1.9	0.0	0.1	0.2	0.0

OCTOBER 10													
Surface	E	G	R	K	M	S	Surface	E	G	R	K	M	S
1	8.5	8.0	8.0	8.0	7.5	7.5	1	8.2	7.4	5.5	5.4	5.5	5.5
2	8.5	8.0	8.0	8.0	7.5	8.0	2	8.0	7.4	5.5	5.4	5.5	5.5
3	8.5	8.0	8.0	8.0	7.5	8.0	3	7.7	7.0	5.5	5.4	5.5	5.5
4	8.0	8.0	8.0	8.0	7.5	8.0	4	7.0	6.0	5.5	5.1	5.5	5.5
5	7.5	8.0	8.0	8.0	7.5	8.0	5	6.8	5.9	5.5	5.1	5.5	5.5
6	7.5	8.0	8.0	8.0	7.5	8.0	6	6.2	5.7	5.5	5.1	5.5	5.5
7	7.5	8.0	8.0	8.0	7.5	8.0	7	5.8	5.7	5.5	5.1	5.4	5.5
8	7.5	8.0	8.0	8.0	7.5	8.0	8	5.5	5.6	5.5	5.1	5.4	5.5
9	7.5	8.0	8.0	8.0	7.5	8.0	9	5.4	5.6	5.5	5.1	5.4	5.5
10	7.5	8.0	8.0	8.0	7.5	8.0	10	5.4	5.6	5.5	5.1	5.4	5.5
11	7.5	8.0	8.0	8.0	7.5	8.0	11	5.4	5.6	5.5	5.1	5.3	5.5
12	7.5	8.0	8.0	8.0	7.5	8.0	12	5.4	5.6	5.5	5.1	5.4	5.5
13	7.5	8.0	8.0	8.0	7.5	8.0	13	5.4	5.6	5.5	5.1	5.4	5.5
14	7.5	8.0	8.0	8.0	7.5	8.0	14	5.4	5.5	5.5	5.1	5.4	5.5
15	7.5	8.0	8.0	8.0	7.5	8.0	15	5.4	5.5	5.5	5.1	5.4	5.5
MEAN TEMP	7.8	8.0	8.0	8.0	7.5	8.0	MEAN TEMP	6.1	6.0	5.5	5.3	5.4	5.5
MAX & T'S	1.0	0.0	0.0	0.0	0.0	0.0	MAX & T'S	2.8	1.9	0.0	0.1	0.2	0.0

NOVEMBER 17													
Surface	E	G	R	K	M	S	Surface	E	G	R	K	M	S
1	8.5	8.0	8.0	8.0	7.5	8.0	1	8.2	7.4	5.5	5.4	5.5	5.5
2	8.5	8.0	8.0	8.0	7.5	8.0	2	8.0	7.4	5.5	5.4	5.5	5.5
3	8.5	8.0	8.0	8.0	7.5	8.0	3	7.7	7.0	5.5	5.4	5.5	5.5
4	8.0	8.0	8.0	8.0	7.5	8.0	4	7.0	6.0	5.5	5.1	5.5	5.5
5	7.5	8.0	8.0	8.0	7.5	8.0	5	6.8	5.9	5.5	5.1	5.5	5.5
6	7.5	8.0	8.0	8.0	7.5	8.0	6	6.2	5.7	5.5	5.1		

Pickering GS 'B'

May - December 1981

Surface	E	G	H	K	M	S
1	9.5	9.6	9.9	9.7	10.0	10.0
2	9.6	10.0	10.0	10.0	9.8	10.0
7	13.6	10.0	9.8	9.9	9.8	12.2
3	10.5	9.8	10.0	9.8	9.7	10.6
4	9.8	9.8	9.5	9.6	9.9	12.2
5	9.9	9.6	9.6	9.7	9.8	11.1
6	9.8	9.8	9.7	9.6	9.7	11.0
7	9.7	9.5	9.7	9.4	9.5	9.7
8	9.0	9.1	9.7	9.9	9.5	10.6
9	9.0	8.8	9.1	9.8	9.6	9.8
10	9.0	8.8	9.1	9.8	9.7	9.7
11	8.5	8.5	8.1	9.0	9.5	9.5
12	8.7	8.7	8.6	9.6	9.5	9.5
13	7.8	8.7	8.5	9.1	9.8	9.0
14	7.1	7.1	8.0	10.1	10.0	9.6
15	8.0	8.2	8.6	10.0	10.0	10.6
16	8.0	8.2	8.6	10.0	10.0	10.6
17	9.6	9.6	9.6	9.6	9.6	9.6
MEAN D.D.	9.6	9.6	9.6	9.6	9.6	9.6
MAX D.D.	9.6	9.6	9.6	9.6	9.6	9.6

Surface	E	G	H	I	J
1	0.9	0.9	9.2	9.0	0.9
2	0.9	0.9	9.1	9.0	0.0
3	0.8	0.9	9.1	9.0	0.0
4	0.8	0.9	9.1	9.0	0.8
5	0.8	0.9	9.1	9.0	0.9
6	0.8	0.9	9.1	9.0	0.0
7	0.9	0.9	9.1	9.0	0.0
8	0.9	0.9	9.1	9.0	0.0
9	0.8	0.9	9.1	9.0	9.1
10	0.8	0.0	9.1	9.1	9.1
11	0.8	9.0	9.1	9.0	9.1
12	0.8	9.0	9.1	9.1	9.2
13	0.9	9.0	9.1	9.1	9.2
14	9.1	9.0	9.0	9.2	9.2
15	9.0	9.1	9.0	9.4	9.1
MEAN D.O.	0.9	0.9	9.1	9.0	0.0
MAX D.O.	0.9	0.2	0.2	0.4	0.2

Surface	E	G	H	K	M	S
1	11.5	11.5	11.9	12.0	12.0	12.8
2	12.0	11.6	12.0	12.0	12.4	10.8
3	12.4	12.0	12.1	12.0	12.2	11.1
4	12.6	12.2	12.1	12.4	12.0	11.4
5	12.0	12.3	12.9	12.4	12.0	11.6
6	12.6	12.5	12.4	12.6	12.2	11.8
7	12.5	12.4	12.4	12.5	12.2	11.0
8	12.4	12.2	12.8	12.4	12.4	11.9
9	12.2	12.2	12.4	12.2	12.4	11.9
10	12.1	12.2	12.0	12.2	12.2	12.0
11	12.0	12.0	12.0	12.0	12.0	12.2
12	11.8	12.1	12.0	12.0	12.0	12.4
13	11.6	12.1	12.0	12.2	11.8	12.4
14	11.5	12.2	12.2	12.4	11.8	12.4
15	11.4	12.4	12.4	12.6	12.4	12.4
MEAN D.O.	12.1	12.1	12.1	12.2	12.2	11.9
MAX D.O.	1.2	1.0	0.5	0.6	1.0	1.6

Surface	S	T	R	K	M	S
1	11.0	16.1	16.1	16.1	13.9	13.7
2	11.0	16.1	16.1	16.1	13.6	13.4
3	11.0	16.1	16.1	13.6	13.6	13.1
4	16.0	16.0	16.1	13.9	13.7	13.5
5	16.0	16.0	16.1	16.0	13.9	13.6
6	13.6	16.1	16.1	13.6	13.6	13.6
7	11.7	13.0	16.1	13.6	13.5	13.0
8	11.5	13.9	16.1	13.6	13.6	13.6
9	13.4	13.6	16.1	13.7	13.6	13.6
10	13.1	13.6	16.1	13.6	13.5	13.7
11	13.1	13.4	13.6	13.6	13.5	13.6
12	13.0	13.4	13.6	13.6	13.5	13.6
13	13.0	13.5	13.6	13.5	13.4	13.6
14	13.1	13.3	13.6	13.5	13.6	13.6
15	13.0	13.5	13.6	13.5	13.2	13.5

MEAN D.O. 13.5 13.7 14.0 13.7 13.6 13.6

MAX D.O. 0.8 0.8 0.7 0.6 0.7 0.6

Surface	F	G	H	I	J	K	L	M	N	O
1	13.0	12.6	12.8	13.1	13.0	12.6				
2	13.0	12.6	12.8	13.1	13.1	12.6				
3	12.9	12.6	12.4	13.1	13.1	12.6				
4	12.9	12.6	12.4	13.1	13.1	12.6				
5	12.9	12.6	12.4	13.1	13.1	12.6				
6	13.0	12.6	12.8	13.2	13.0	12.6				
7	13.0	12.6	12.4	13.2	13.0	12.6				
8	13.0	12.6	12.4	13.2	13.0	12.6				
9	12.8	12.6	12.4	13.2	13.0	12.6				
10	12.8	12.6	12.4	13.2	13.0	12.6				
11	12.8	12.6	12.4	13.2	13.0	12.6				
12	12.8	12.6	12.4	13.2	13.0	12.6				
13	12.8	12.6	12.4	13.2	13.0	12.6				
14	12.8	12.6	12.4	13.2	13.0	12.6				
15	12.8	12.6	12.4	13.2	13.0	12.6				
MEAN D.O.	12.9	12.6	12.6	13.2	13.0	12.6				
MAX. D.O.	13.1	12.8	12.8	13.2	13.1	12.8				

NOVEMBER 17											
surface	J	L	M	K	N	S					
1	12.3	12.1	12.6	12.6	12.6	12.5					
2	12.3	12.1	12.6	12.6	12.6	12.5					
3	12.3	12.1	12.6	12.6	12.6	12.5					
4	12.2	12.2	12.3	12.6	12.3	12.8					
5	12.1	12.2	12.3	12.3	12.2	12.6					
6	12.1	12.1	12.3	12.3	12.2	12.6					
7	12.1	12.0	12.1	12.3	12.2	12.6					
8	12.1	11.9	12.2	12.3	12.2	12.3					
9	12.1	11.9	12.2	12.2	12.2	12.3					
10	12.1	11.8	12.1	12.2	12.3	12.3					
11	12.1	11.8	12.1	12.2	12.3	12.5					
12	12.0	11.8	12.1	12.2	12.3	12.2					
13	11.9	11.8	12.1	12.0	12.2	12.2					
14	12.0	11.8	12.2	12.1	12.1	12.2					
15	12.1	11.8	12.2	12.1	12.1	12.2					
MEAN D.O.	12.2	12.0	12.3	12.1	12.3	12.3					
MAX D.O.	0.5	0.5	0.1	0.6	0.1	0.1					

Surface	E	G	R	K	M	S
1	11.6	11.2	11.2	11.2	11.6	11.2
2	11.6	11.2	11.2	11.2	11.6	11.2
3	11.6	11.2	11.2	11.2	11.6	11.2
4	11.6	11.2	11.2	11.2	11.6	11.2
5	11.6	11.2	11.2	11.2	11.6	11.2
6	11.6	11.2	11.2	11.2	11.6	11.2
7	11.6	11.2	11.2	11.2	11.6	11.2
8	11.6	11.2	11.2	11.2	11.6	11.2
9	11.6	11.2	11.2	11.2	11.6	11.2
10	11.6	11.2	11.2	11.2	11.6	11.2
11	11.6	11.2	11.2	11.2	11.6	11.2
12	11.6	11.2	11.2	11.2	11.6	11.2
13	11.6	11.2	11.2	11.2	11.6	11.2
14	11.6	11.2	11.2	11.2	11.6	11.2
15	11.6	11.2	11.2	11.2	11.6	11.2
MEAN D.O.	11.5	11.2	11.2	11.2	11.6	11.2
MAX D.O.	0.2	0.0	0.0	0.0	0.0	0.0

Surface	K	G	H	K	M	S
1	10.9	10.9	10.9	11.4	10.8	10.9
2	10.9	10.9	10.9	11.0	10.8	11.1
3	10.9	10.9	10.9	11.0	10.8	10.9
4	10.9	10.9	10.9	11.0	11.0	10.9
5	10.8	10.9	10.9	10.9	10.9	10.9
6	10.9	10.9	10.9	11.0	10.9	10.9
7	10.9	10.9	10.9	11.0	11.0	10.9
8	10.9	10.9	10.9	11.1	11.0	10.9
9	10.9	10.9	11.0	11.1	11.0	10.9
10	10.9	10.9	11.1	11.1	11.0	10.9
11	11	11	10.8	11.1	11.1	10.9
12	10.9	10.8	11.1	11.1	11.0	10.9
13	10.8	10.8	11.1	11.1	11.0	10.8
14	10.8	10.8	11.1	11.1	11.1	10.9
15	10.8	10.8	11.1	11.0	11.1	10.9
MEAN D.O.	10.9	10.9	11.0	11.0	11.0	10.9
MAX. D.O.	0.1	0.1	0.2	0.2	0.1	0.1

APPENDIX VI

Substrate Composition at the Sampling Locations
for Attached Algae - Pickering GS - 1981

Month	July							August							October									
Transect	E	A	G	I	B	K	M	O	E	A	G	I	B	K	M	O	E	A	G	I	B	K	M	O
Substrate																								
Sand	100	30	100	-	100	80	-	100	100	25	34	-	100	100	100	100	100	100	50	-	100	100	100	100
1 m	100	100	100	-	75	100	100	-	100	100	100	5	20	100	100	10	100	100	100	-	75	100	100	30
3 m	100	100	100	40	-	-	100	-	100	100	35	5	-	-	-	-	100	50	50	50	-	-	100	-
7 m	100	100	100	5	10	-	-	-	100	100	-	-	5	-	-	-	100	100	50	80	-	-	50	-
12 m	100	100	5						100	100							100	100	50				50	
Gravel and Pebble	-0	10	-	-	-	-	75	-	-	25	33	-	-	-	-	-	-	-	20	50	-	-	-	-
3 m	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	10	-	-	-	50	-	-	-	-
7 m	-	-	-	10	-	50	-	-	-	-	40	10	20	25	-	25	-	25	25	30	-	30	-	-
12 m	-	-	25	-	30	-	-	-	-	-	20	10	15	15	20	15	-	-	25	-	20	-	-	-
Cobble and Boulder	-	60	-	100	-	20	25	-	-	50	33	100	-	-	-	-	-	-	30	50	-	-	-	-
3 m	-	-	-	100	25	-	-	100	-	-	-	85	80	-	-	80	-	-	-	50	25	-	-	70
7 m	-	-	-	50	100	50	-	100	-	-	25	85	80	75	-	75	-	25	25	20	100	70	-	100
12 m	-	-	35	90	70	-	100	100	-	-	40	15	80	25	80	85	-	-	25	20	80	-	50	100
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12 m	-	-	35	-	-	100	-	-	-	-	40	75	-	-	-	-	-	-	-	-	-	100	-	-

APPENDIX VII

(Microfiche)

1. Phytoplankton Appendix
2. Zooplankton Appendix
3. Zoobenthos Appendix
4. Larval Fish Appendix
5. Juvenile and Adult Fish Appendix

APPENDIX VIII

Seasonal Abundance of Larval Fish Caught at Pickering GS 'B' -1981 (Pickering Whitefish Data Included)

Sampling Date	Smelt	Alewife	Others	Total
April 10	-	-	-	-
15	-	-	1 (Round whitefish)	1
27	-	-	1	1
May 5	1	-	-	1
11-14	21	-	4	25
19	372	-	-	372
27	252	-	10	262
June 11	340	-	8	348
23	117	-	2	119
July 8	11	3432	239	3679
22	1	599	38	638
August 5	0	702	20	722
19	3	204	-	207
Grand Total				6375

APPENDIX IX

Mean Total Lengths (mm $\pm$ SD) of Larval Smelt and Alewife Caught in Forebay Sets and Lake Tows - Pickering, 1981

(Data from Pickering Larval Whitefish Study Included)

	April 10	April 15	April 27	May 5	May 11-14	May 19	May 27	June 11-12	June 23	July 8	July 22	Aug 5	Aug 19
Smelt	-	-	-	5.0 - n=1	6.2 $\pm$ 0.4 n=21	6.0 $\pm$ 0.4 n=159	5.7 $\pm$ 0.4 n=199	6.1 $\pm$ 0.4 n=235	6.6 $\pm$ 0.5 n=94	21.6 $\pm$ 5.7 n=7	9.0 - n=1	-	39.3 $\pm$ 1.9 n=3
Alewife	-	-	-	-	-	-	-	-	-	4.5 $\pm$ 0.4 n=334	4.3 $\pm$ 0.3 n=233	4.7 $\pm$ 1.6 n=278	8.7 $\pm$ 2.9 n=160

APPENDIX X

VALUES OF LARVAL FISH DENSITIES (NO/1000 m³) ALONG TRANSECTS O, M, K, I, G and E,
FOR SNELT ALEWIFE, CARP AND GIZZARD SHAD DURING PEAK ABUNDANCE PERIODS AT PICKERING CS 'B' - 1981

Sampling Date	Contour Depth (m)	TRANSECT																		Gizzard Shad		
		Smelt						Alewife						Carp								
		O	M	K	I	G	E	O	M	K	I	G	E	O	M	K	I	G	E			
May 19	1	80	360	245	1660	140	10															
	3	-	100	185	1060	105	10															
	7	10	80	100	35	55	10															
May 27	1	65	370	150	125	115	30															
	3	10	90	315	230	265	10															
	7	105	125	405	105	240	10															
June 11	1	80	90	75	255	135	35															
	3	115	25	150	260	85	30															
	7	35	30	105	415	325	95															
June 23	1	10	60	10	5	80	215															
	3	-	20	30	-	10	180															
	7	215	-	15	20	10	20															
July 8	1	2365	635	275	4545	9230	4880	2365	635	275	4545	9230	4880	-	-	-	620	1115	-	10	-	70
	3	4560	330	590	6160	4805	3150	4560	330	590	6160	4805	3150	-	-	-	1245	315	-	10	-	55
	7	140	270	290	680	445	6335	140	270	290	680	445	6335	-	-	-	-	-	-	-	-	-
July 22	1	50	50	270	70	795	330	50	50	270	70	795	330	80	20	110	25	10	-			
	3	445	115	390	2205	1130	255	445	115	390	2205	1130	255	-	160	50	-	10	-			
	7	110	-	20	750	635	765	110	-	20	750	635	765	-	-	-	-	-	-			
August 5	1	660	225	340	250	20	255	660	225	340	250	20	255							85	5	-
	3	1760	460	290	150	55	160	1760	460	290	150	55	160							-	15	-
	7	460	330	205	40	5	105	460	330	205	40	5	105							-	-	-
August 19	1	10	30	20	35	120	85	10	30	20	35	120	85									
	3	40	45	295	190	80	30	40	45	295	190	80	30									
	7	5	15	70	155	305	80	5	15	70	155	305	80									

APPENDIX XI

CATCH IN DUPLICATE LARVAL TOWS, APRIL 10 - MAY 14, 1981
(PICKERING LARVAL ROUND WHITEFISH DATA)
PICKERING GS 'B', 1981

	Rouge River			Frenchman's Bay			Pickering A			Pickering B			East of Moore Pt			Duffin's Creek			Siacoe Pt			Whitby West			Whitby East		
	1 m	7S*	7B**	1 m	7S	7B	Bay	1 m	7S	7B	1 m	7S	7B	1 m	7S	7B	1 m	7S	7B	1 m	7S	7B	1 m	7S	7B		
April 10 Smelt Eggs			X			X	X			21	X		X						X								
April 15 Smelt Eggs Round Whitefish								1								1											
April 27 Smelt Eggs Mottled Sculpin***						4			11	22			3														
May 5 Smelt Smelt Eggs		14		1	8	4		1	47	17		3	2	11	4												
May 14 Smelt Smelt Eggs Mottled Sculpin *** White Sucker Yellow Perch Percidae	6		1		1		1	2	2			1	1	1	1	1											

* 7 m surface

** 7 m bottom

*** Juvenile and Adult

X No Sample

APPENDIX XII

Scientific Names of Fish Species - Pickering GS 'B'

<u>Common Name</u>	<u>Scientific Name</u>
Alewife	<i>Alosa pseudoharengus</i>
Brown Bullhead	<i>Ictalurus nebulosus</i>
Smelt	<i>Osmerus mordax</i>
White Sucker	<i>Catostomus commersoni</i>
Gizzard Shad	<i>Dorosoma cepedianum</i>
Yellow Perch	<i>Perca flavescens</i>
White Perch	<i>Morone americana</i>
Round Whitefish	<i>Prosopium cyclindraceum</i>
White Bass	<i>Morone chrysops</i>
Emerald Shiner	<i>Notropis atherinoides</i>
Spottail Shiner	<i>Notropis hudsonius</i>
Longnose Dace	<i>Rhinichthys cataractae</i>
Splake	<i>Salvelinus namaycush</i> X <i>S. fontinalis</i>
Brown Trout	<i>Salmo trutta</i>
Pumpkinseed	<i>Lepomis gibbosus</i>
Smallmouth Bass	<i>Micropterus dolomieu</i>
Carp	<i>Cyprinus carpio</i>
Rainbow Trout	<i>Salmo gairdneri</i>
Golden Shiner	<i>Notemigonus crysoleucas</i>
Slimy Sculpin	<i>Cottus cognatus</i>
Yellow Pickerel	<i>Stizostedion vitreum</i>
Rock Bass	<i>Ambloplites rupestris</i>
Log Perch	<i>Percina caprodes</i>
Freshwater Drum	<i>Aplodinotus grunniens</i>
Coho Salmon	<i>Oncorhynchus kisutch</i>
Northern Pike	<i>Esox lucius</i>
Lake Chub	<i>Couesius plumbeus</i>
Fathead Minnow	<i>Pimephales promelas</i>
American Eel	<i>Anguilla rostrata</i>
Mottled Sculpin	<i>Cottus bairdii</i>
Longnose Sucker	<i>Catostomus catostomus</i>
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>
Common Shiner	<i>Notropis cornutus</i>
Bluntnose Minnow	<i>Pimephales notatus</i>
Johnny Darter	<i>Etheostoma nigrum</i>
Spotfin Shiner	<i>Notropis spilopterus</i>
Longnose Gar	<i>Lepisosteus osseus</i>
Cisco	<i>Coregonus artedii</i>
Sea Lamprey	<i>Petromyzon marinus</i>

APPENDIX XIII

RESULTS OF THREE-WAY ANALYSIS OF VARIANCE FOR ALEWIFE, SMELT AND WHITE SUCKER
GILL NET DATA - PICKERING CS 'B', 1981

Species	Values of Calculated F Statistic						
	Transect	Month	Depth Contour	Transect x Depth Contour	Transect x Month	Depth Contour x Month	Transect x Depth Contour x Month
Alewife	*0.56 [3,64]	**5.57 [7,64]	*5.20 [1,64]	*0.54 [3,64]	*0.72 [21,64]	**3.09 [7,64]	*1.38 [21,64]
Smelt	*1.89 [3,64]	**19.11 [7,64]	**23.39 [1,64]	**5.02 [3,64]	*0.85 [21,64]	**4.73 [7,64]	**2.56 [21,64]
White Sucker	**4.88 [3,64]	**63.38 [7,64]	*9.79 [1,64]	**12.70 [3,64]	**4.77 [21,64]	**7.47 [7,64]	**6.51 [21,64]

* Not significant
** Significant
P < 0.01

1000

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APPENDIX XIV

AVERAGE NO OF BIRDS OBSERVED (LIGHTED) PER 10 MINUTE INTERVAL
PICKERING 1981-1982

Pickering 'A' Discharge																Pickering 'A' Intake															
Sept 25	Oct 9	Oct 23	Nov 6	Nov 20	Dec 4	Dec 18	Jan 5	Jan 15	Jan 29	Feb 15	Feb 26	Mar 15	Mar 26	Apr 8	Sept 25	Oct 9	Oct 23	Nov 6	Nov 20	Dec 4	Dec 18	Jan 5	Jan 15	Jan 29	Feb 15	Feb 26	Mar 15	Mar 26	Apr 8		
	0.3									86.2	41.7	4	16					0.3					11.3	41.5		1.5					
1					0.3	7.8	8.3	19.5	0.5	18.3	18	3.6	0.5					0.7		2.7		9.7	600	500	34.5	20.9					
																						0.7	150	50	10						
								0.5														1	4	1	2.7						
												1	0.3					0.5			1	1.2	0.7	0.5	0.5	0.7	0.3				
															0.2			0.2				2.2	0.3	5.2	1						
		2						9					1.7																		
			2.5										0.7	22.2	22.8	13.3		0.7	2	2.7	3.2	0.2		1.7							
0.5	2.3		4.5		1.3	0.5	23.7	2																1.2							
	0.5		1.5			5.3	1	5							1.7	1		0.2		3	0.7			1.2		0.2					
3.5	9.2		4.7	26.1	1.3	10	10.3	4.7		1		1	18.3	16	87.6	27.5	4.7	18.7	22.5	4.7				1.5	0.2			0.8			
						150										113.3								0.5		0.5					
													0.7																		

APPENDIX XIV

AVERAGE NO OF BIRDS OBSERVED (LIGHTED) PER 10 MINUTE INTERVAL
PICKERING 1981-1982

	Duffin Creek																Ajax															
	Sept 25	Oct 9	Oct 23	Nov 6	Nov 20	Dec 4	Dec 18	Jan 5	Jan 15	Jan 29	Feb 12	Feb 26	Mar 15	Mar 26	Apr 8	Sept 25	Oct 9	Oct 23	Nov 6	Nov 20	Dec 4	Dec 18	Jan 5	Jan 15	Jan 29	Feb 15	Feb 26	Mar 15	Mar 26	Apr 8		
Common Loon			0.2	1	86.3	1	37.3	35.5			12.3	12	62.5	4.3	2.3					0.5		73.3						0.7				
Canada Goose			2	2							0.5															5						
Mute Swan																																
Whistling Swan																																
Mallard	6.5	4.6	33.8	7	4.3	197.3	27.3	18	2	2	62.3	40.3	366	0.7	2.7		1			300	19	69	23.2			13.7	2	50.5	12.5	2.3		
Black Duck						36.7	0.3								6.7													92.5		8		
Gadwall		0.5		91	75.7	2																										
Pintail						8.8																										
Green-winged Teal		1.3																														
Blue-winged Teal		1.3																														
American Wigeon			2.3			7																										
Ring-necked Duck			0.3			0.3																										
Scaup Sp.																																
Common Goldeneye				0.7	3.5	14.7	0.3	43.2	3					2	1				0.8	2.7	1	2.5	34.8			0.2	5.3	6.7	1.2	0.8		
Murrelet							1.3								23.5			4.5	5.8	2.3	2.3				2	4.8	4	15.8	19.8	1.5		
Common Merganser			15.8		17.3	1		16.5					4.7		1.8			2.3								600	6.3			2.5		
Red-breasted Merganser																																
Merganser sp	0.3																															
Herring Gull		0.8	0.8	1.7	13.5	5		0.5			9.7		5.5	0.8					0.7	0.7	2					0.2				2		
Gt. Black-backed Gull				0.3																												
Ring-billed Gull																																
Bonaparte Gull	7.3	4	60.5	18.7	16.3								302.2	0.8	15.2					5.8								1	1	38.3		
Shoveller						0.2																										
Coot		0.2																														
Great Blue Heron			0.2																											0.5		

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